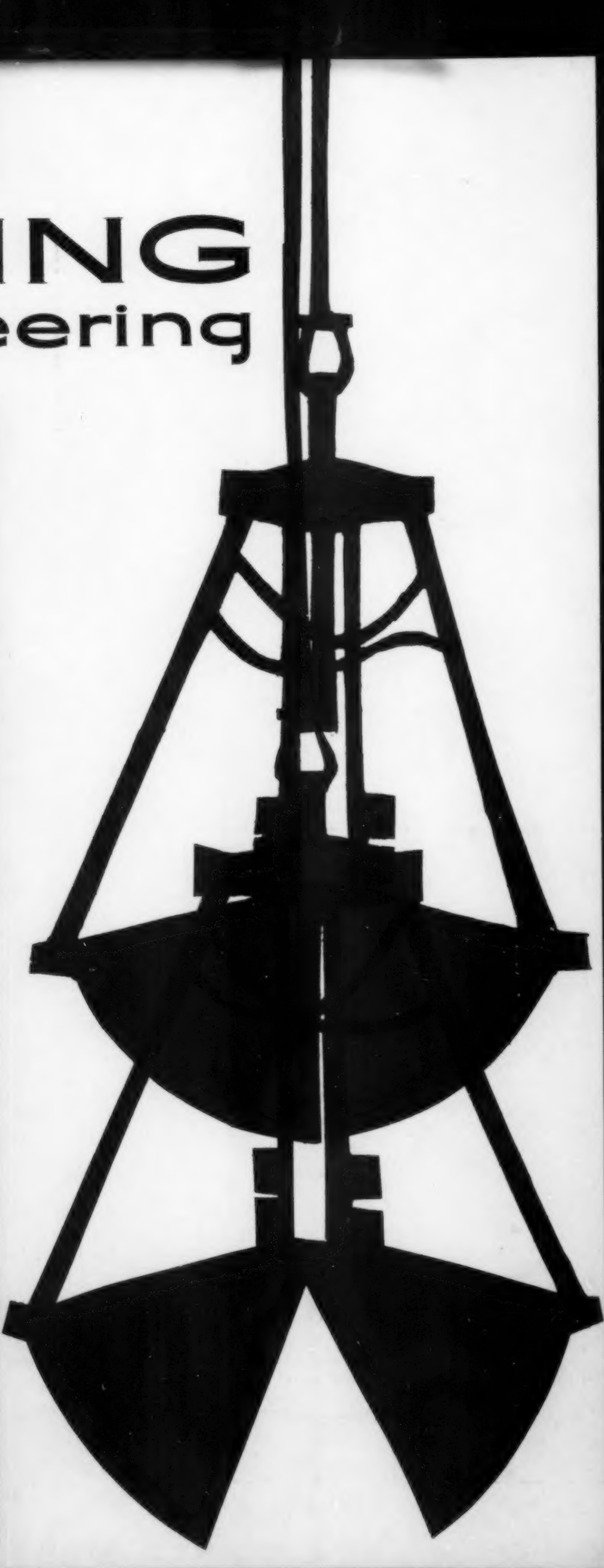
MINING engineering

JULY 1958



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Coming Events

July 26, AIME Adirondack Section, weekend with wives, Ottawa.

Aug. 23, AIME Adirondack Section, golf and speaker, Tupper Lake, N. Y.

Sept. 2-6, UPADI, 5th convention, Montreal.

Sept. 7-11, Sixth World Power Conference, Montreal, with field trip Sept. 11-15.

Sept. 16-19, Sixth International Congress on Large Dams, New York.

Sept. 17-19, AIME Rocky Mountain Minerals Conference, Newhouse Hotel, Salt Lake City.

Sept. 18-20, Rocky Mountain Assn. of Geologists, symposium on Pennslyvanian rocks of Colorado and field trip, Maroon Basin, northwest Colorado.

Sept. 22-25, American Mining Congress Mining Show, Civic Auditorium, San Francisco.

Sept. 27, AIME Adirondack Section, National Lead trip, Tahawus, N. Y.

Oct. 2-4, Annual Drilling Symposium, University of Minnesota, Minneapolis.

Oct. 9-10, AIME-ASME Solid Fuels Conference, Hotel Chamberlin, Old Point Comfort, Va.

Oct. 13-16, Soc. of Exploration Geophysicists, annual meeting, Gunter Hotel, San Antonio, Texas.

Oct. 15-17, Energy Resources Conference, Brown Palace Hotel, Denver.

Oct. 16, AIME Utah Section, speaker: L. V. Olson; subject: Progress in Air Pollution Control; Salt Lake City.

Oct. 16-18, 9th Annual Field Conference, New Mexico Geological Soc. in cooperation with Arizona Geological Soc., Black Mesa Basin of northeastern Arizona.

Oct. 20-23, National Clay Conference, Natural History Bldg., Smithsonian Inst., Washington, D. C.

Oct. 23-25, AIME Mid-America Minerals Conference, Chase-Park Plaza Hotels, St. Louis.

Oct. 24, AIME Lehigh Valley Section, trip to Niki Installation, Doylestown, Pa.

Nov. 7, AIME Pittsburgh Section and AIME NOHC Pittsburgh Section, 13th annual Off-the-Record Meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 13-14, Missouri School of Mines and Metallurgy, 4th annual symposium on mining research, University of Missouri, Rolla, Mo.

Dec. 1, AIME Arizona Section, annual meeting, Pioneer Hotel, Tucson, Ariz.

Dec. 5, AIME Lehigh Valley Section, ladies' night, Lehigh Valley Club, Allentown, Pa.

Dec. 11, AIME Utah Section, panel discussion on Place of Research in the Minerals Industries; members: chairman J. M. Ehrhorn, S. R. Zimmerley, J. B. Clemmer, W. M. Fassell, Jr., J. R. Lewis; Salt Lake City.

Feb. 15-19 1959, AIME Annual Meeting, Sheraton-Palace, St. Francis, Sir Francis Drake Hotels, San Francisco.

Apr. 5-10, EJC 1959 Nuclear Congress, Public Auditorium, Cleveland.

SOCIETY OF MINING ENGINEERS AIME

MINING engineering

VOL. 10 NO. 7 ABC JULY 1958

COVER

Tight quarters in small shafts makes mucking difficult. Artist Herb McClure illustrates one solution on this month's cover—air-operated clamshells. For further details on this type of operation, see the article on page 773.

ARTICLES

TRANSACTIONS

FEATURES

Published monthly by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 West 39th St., New York 18, N. Y Telephone: PEnnsylvania 6-9220. Subscription $8 per year for non-AIME members in the U. S., & North, South, & Central America; $10 foreign; $6 for AIME members, or $4 additional for members only in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies, $.75; single copies foreign, $1.00; special issues, $1.50. The AIME is not responsible for any statement made or opinion expressed in its publications. Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by The National Research Bureau. Second class mail privileges authorized at New York, N. Y., and additional entry established at Manchester, N. H Number of copies of this issue 15,100.

PERSONNEL

THE following employment items are made available to AIME members on a non-profit basis by the Engineering Societies Personnel Service, Inc. (Agency) operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

—MEN AVAILABLE—

General Manager or Assistant, B.A.Sc., age 41. Experience as senior geologist (industrial minerals), 3 years; field engineer (metallic minerals), 4¾ years; plant engineer, lime plant, 3 years; assistant mill superintendent, silica sand plant, 3¼ years. Prefer Canada or northern U. S. M-426.

Exploration Geologist, B.S. and M.S., age 29. Three years practicing engineer, chemical industry; two years geological engineer, exploration. Prefer foreign location. M-427.

Geologist, age 45. Seventeen years experience western mines and recently in Mexico; sampler in underground copper mines, geologist in lead-zinc-silver mines; field geologist in titanium prospect area. Handled mapping and map-posting, diamond drilling, sampling for and calculating ore reserves, mine development, and exploration. Will travel but prefer western location or Latin American work. 1236-San Francisco.

Administrative or Supervisor (mineral), B.S. in mining engineering, age 46. Several years administrative and supervisory experience small mines and concentrators and examination and exploration of deposits, particularly rare metals. Registered professional engineer, mining and electrical. Prefer U. S. 1257-San Francisco.

Mining Geologist or Petroleum Geologist, B.Sc. in geology, B.S. in industrial relations. One year's experience personnel manager construction company, two seasons field geologist large mining company, logging core, some geophysical work, mapping. One year as mine geologist, Canada, underground mapping. Prefer western or eastern U. S. or Canada, consider foreign. M-428.

Production or Mine Manager or Consultant, E.M. and M.S. in geology, age 50. Consultant, seven years (including three as professor); ten years as superintendent and general manager (surface and underground), both U. S. and foreign; ten years foreman, engineer, geologist including various construction projects. Location, immaterial. M-429.

General Manager, Mining, age 43. Broad experience in mining and milling, operations and research, embracing many minerals, except iron. Three years in research and sales. Desires challenging position. Prefer western U. S. M-430.

Manager, General Superintendent, age 43, mining engineer. Twenty-two years experience mining and milling, exploration, development, production. Open pit and underground, metallics and nonmetallics. Broad experience in labor relations and administration. Available 30 days notice. Location, immaterial. M-431.

Geologist, M.Sc., age 41. Nineteen years mining and exploration geology, U. S., Canada, Mexico including mapping, drilling, development, evaluation, geophysical studies. Good record managing field projects. Desires responsible position geological or exploration program. M-432.

(Continued on page 736)

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LETTERS

Its All in a Name

As usual, the editorial section entitled *Trends* in the May 1958 issue, is interesting reading. The article, "Corporate Struggle—Find a New Name" is really good reading.

However, I must point out that the researchers that were hired by the National Cylinder Gas Co. fell down badly when it came to translating theory to practice. The name of "Chemetron Corporation" that they submitted to their directors can be pronounced three different ways [Chem'e·tron, Chem·e'tron, Chem·e·tron'] according to the part of the country in which one lives. Here is hoping that some hard-headed director realized that before inflicting the name on the unsuspecting world.

E. H. Brown

Consulting Metallurgical Engineer
Willowdale, Ont., Canada

Anthracite Error

On page 238 of MINING ENGINEERING February 1958 issue, the first paragraph on Anthracite states "The quarter-million-dollar a year" anthracite industry employs some 30,000 men. I believe this should be "quarter-billion-dollar a year."

I realize that the anthracite industry is in the doldrums, but the value of its product is still greater than what you have mentioned.

Howard B. Link

Editor's Note: *Substitution of the letter "M" for the letter "B" made quite a serious drop in the scale of the anthracite industry.*

Abstracts

". . . think that the idea of putting out the abstracts in this form [in the January issue] is a very fine idea and should cut down costs considerably inasmuch as people will only be getting what they want in the line of preprints. It should also give an idea of what they want printed."

Editor's Note: *Among the many comments received on the Society of Mining Engineers' Preprint Program and the running of abstracts in* MINING ENGINEERING, *the following comments are typical. . .*

Personnel

(Continued from page 734)

—POSITIONS OPEN—

District Sales Representative, for manufacturer of heavy construction loading equipment. Must be experienced in application of excavating and loading equipment. Sales experience desirable. Headquarters, New York. W6179.

Mining Geologist, 28 to 35, with minimum of one year's graduate work in hard rock geology, minimum of three years experience in mining geology and/or mining exploration with major companies. Extensive travel in western U. S. during the field season. Salary dependent upon experience and qualifications; minimum will be in the range of $5500 to $6250 per year. Headquarters west. W6166.

Manager, 40 to 50, graduate mining engineer, for metal mine in Bolivia. Must have previous experience as mine manager and have complete knowledge of Spanish. Salary, open. F6156.

Mining Valuation Engineer, graduate in mining, with considerable background in the valuation of small mining properties. Must know Spanish. Salary, $12,000 a year plus 20 pct bonus. One-year contract. Location, South America. F6155.

Mine Shift Boss, for gold lode property; engineering graduate, with four to five years underground experience. Some knowledge of Spanish. Single status. Salary, $4800 a year, plus approximately 2½ months extra pay per year in benefits imposed under local labor laws. Location, South America. F6129.

Applications Engineer, graduate mining engineer, for development of applications of a product line to the mining industry. Will involve recommendations for new equipment, suggestions of design, market analysis, followup on manufacture, and arranging for and observing field test of experimental units. Travel approximately 50% of time. Headquarters, Southwest. W6111.

Geologist/Geophysicist, master's degree in geology desirable, with minimum of two years full time geological-geophysical employment. Under supervision will work directly with party chief in coordination and evaluation of gravimeter and magnetometer work and make geological interpretations of reflection seismic data, integrating both geology and geophysics in progress and final reports in all sections and maps submitted. Location, North Africa. F6197.

Mine Foremen, for underground mine operations; B.S. in mining engineering and at least three years experience in supervisory position such as assistant mine foreman. Must have qualifications for future advancement. Three-year contracts with transportation both ways and salary while traveling. Location, South America. F5973 (b).

Mining Engineer, B.S. in mining or geology, with practical experience in field of hydraulic mining and geology, to study brine production methods used on present wells and make recommendations to improve methods of operation. Through use of available geological data and the development of additional data, make recommendations for the drilling and development of additional wells. Salary, open. Fringe benefits. Location, East. W5960.

Superintendent, about 30 to 40, to supervise prodution of Frasch sulfur mine operation. Must have engineering degree and at least ten years experience all phases of sulfur production. Location, Mexico. Replies will be kept confidential. F4698S.

BOOKS

Order directly from the publisher all books listed below except those marked • • • The books so marked (• • •) can be purchased through AIME, usually at a discount. Address Irene K. Sharp, Book Dept., AIME, 29 W. 39th St., New York 18, N. Y.

Permian Productacea of Western Australia, Bulletin No. 40, by P. J. Coleman, published by the *Dept. of National Development*, Commonwealth of Australia, Bureau of Mineral Resources, Geology, and Geophysics, 485 Bourke St., Melbourne C.1, Australia, gratis, 189 pp., 1957.—This, in part based on a doctoral thesis, is a study and description of 34 species of the brachiopod superfamily Productacea, all of which are found in western Australia. Included in the booklet are 21 plates, 6 figs., and 3 tables.

The Geology of the South-Western Canning Basin, Western Australia, Report No. 29, by D. M. Traves, J. N. Casey, and A. T. Wells, published by the *Dept. of National Development*, Commonwealth of Australia, Bureau of Mineral Resources, Geology, and Geophysics, 485 Bourke St., Melbourne C.1, Australia, gratis, 76 pp., 1956.—Report describes the geology and geography of the southern part of the Canning (Desert) Basin of western Australia, including a description of the stratigraphical units and a discussion of the tectonics, geological history, and geomorphogeny. There are numerous illustrations and maps.

Mineral Resources of Australia, Natural Abrasives, Summary Report 41, compiled by Z. Kalix and J. Barrie, published by the *Dept. of National Development*, Commonwealth of Australia, Bureau of Mineral Resources, Geology, and Geophysics, 485 Bourke St., Melbourne C. 1, Aus-

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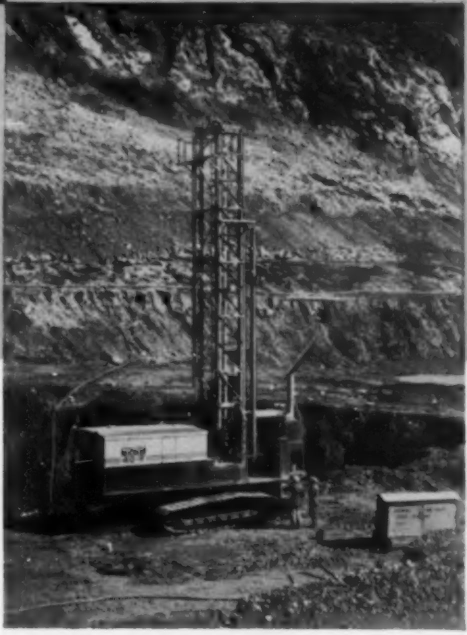

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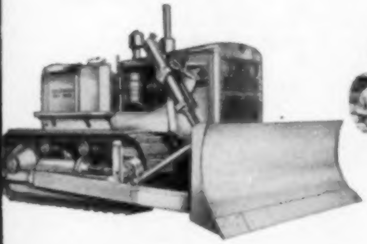

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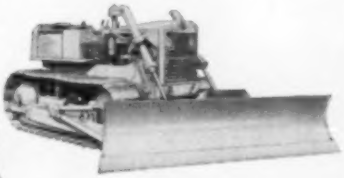
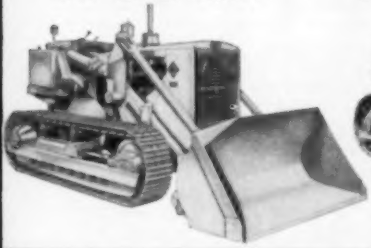
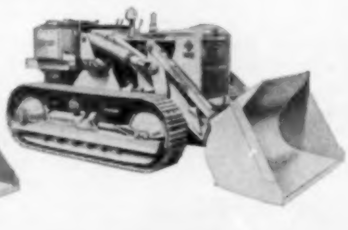


2¼-CU-YD
HD-11G 111 net engine hp 32,000 lb



1½-CU-YD
HD-6G 72 net engine hp 19,600 lb



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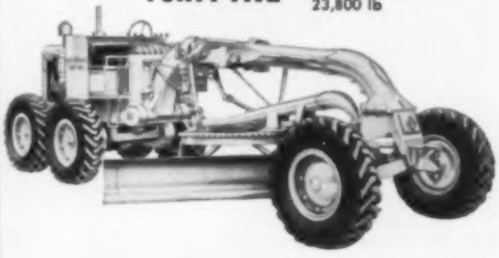
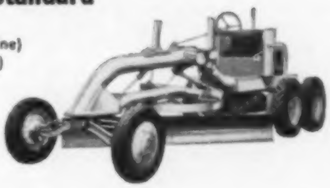
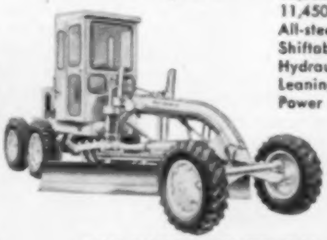


model D standard
50 brake hp
8,800 lb (gasoline)
9,350 lb (diesel)



model D special
50 brake hp
10,900 lb (gasoline)
11,450 lb (diesel)
All-steel cab
Shiftable moldboard
Hydraulic scarifier
Leaning front wheels
Power circle turn



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Books

(Continued from page 736)

tralia, approx. 50¢, 1956.—This booklet covers the status of the natural abrasives industry in Australia, with information on such facets of the industry as production and consumption, sources, prices, and overseas trade. Also included are tables, map, and graph.

Advances in Electronics and Electron Physics, Vol. IX, edited by L. Marton, *Academic Press Inc.*, 111 Fifth Ave., New York 3, N. Y., 347 pp., $9.00, 1957.—This volume centers about the International Geophysical Year and attempts to acquaint geophysicists with some of the electronic methods at their disposal. Studies are presented on such subjects as the aurora borealis, intensity variations in cosmic rays, radio-wave propagation, and contributions of electronics to seismology and geomagnetism. • • •

Human Relations in Industrial Research Management, edited by R. T. Livingston and Stanley H. Milberg, *Columbia University Press*, 2960 Broadway, New York 27, N. Y., 418 pp., $8.50, 1957.—A collection of 27 papers from the 1955 and 1956 Industrial Research Conferences sponsored by Columbia University. Subjects covered are of specific interest to those engaged in individual research and those studying management of research. • • •

The Grenville Problem, Royal Soc. of Canada Special Publications No. 1, edited by James E. Thomson, *University of Toronto Press*, Toronto, Ont., Canada, 119 pp., $3.95, 1956.—A symposium dealing with the geological aspects of the Grenville area, particularly the Canadian portion. These aspects are examined in terms of the increasing importance of mineral searching in this area. • • •

Electrical Construction Cost Manual, by Ralph E. Johnson, *McGraw-Hill Book Co. Inc.*, 431 pp., $10.00, 1957.—To reduce the time necessary to prepare a cost estimate for electrical installations, the author proposes a complete system built around the concept of unit assemblies. He establishes fundamental methods for installing electrical work in various types of construction, develops standard assemblies, and gives a method for estimating the unit costs. • • •

Irrigation and Hydraulic Design, Vol. 2: Irrigation Works, by Serge Leliavsky, *The MacMillan Co.*, 864 pp., $60.00, 1957.—This volume is intended to provide the irrigation and hydraulic designer with all the data, figures, tables, etc., which he may need in his work. As compared with the general fundamentals presented in the first volume, this one is devoted to specific design methods and theory for irrigation works. • • •

Physics and Chemistry of the Earth, Vol. 2, edited by L. H. Ahrens and others, *Pergamon Press*, 122 E. 55th St., New York 22, N. Y., 259 pp., $10.00, 1957.—This is one of a series intended to provide critical survey reviews of the progress within the fields involved. The subject matter of this volume includes: an experimental approach to physical oceanography; a survey of some of the principal abundance data of geochemistry; geochemistry of gallium, indium and thallium; and latitude variation. • • •

Zirconium (Metallurgy of the Rarer Metals, Vol. 2), 2nd edition, by G. L. Miller, *Academic Press* Inc., 111 Fifth Ave., New York 3, N. Y., 548 pp., $12.50, 1957.—An extensive study of zirconium in all its phases. Methods for the production of this metal are examined with particular reference to the Kroll and iodide (van Arkel) processes. The physical, structural, and mechanical properties of zirconium are presented in detail, and some chapters are concerned with certain specific aspects. This edition contains a considerable amount of information not available at the time of the first edition because of security reasons. • • •

Growth Survey of the Atomic Industry, 1958-1968, published by *Atomic Industrial Forum Inc.*, 3 E. 54th St., New York 22, N. Y., 84 pp., $25.00, 1958.—This report has been developed as a guide to companies wishing to undertake various market studies in the field, as well as to those that may wish to measure their own business estimates against a composite estimate for the total industry. The sections of the report cover such subjects as nuclear power projections; volume of reactor business in the United States; and factors affecting foreign nuclear power growth. There are more than 50 charts and tables. • • •

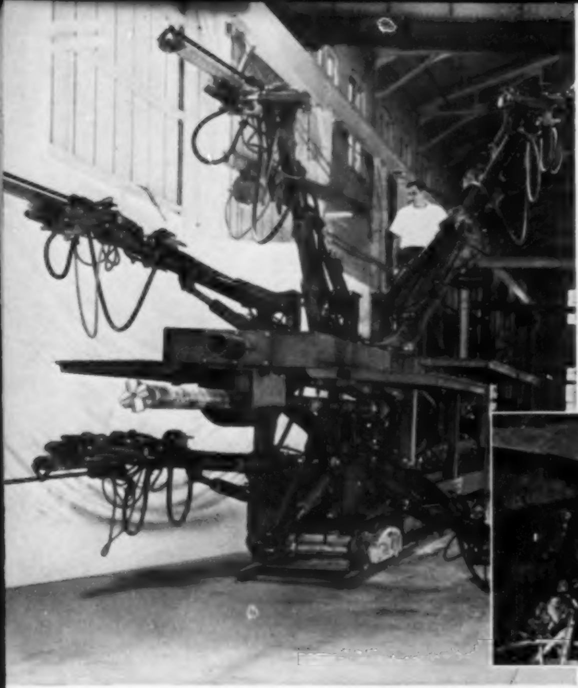
Special Report on Results of Renegotiation, published by *The Renegotiation Letter*, Evans Bldg., Washington 5, D. C., 116 pp., $10.00, 1957.—The data given reveals why the Renegotiation Board ordered 49 defense contractors and subcontractors to refund $54 million of excess profits. In each case the financial operations of the companies are covered, together with the amount of profit the companies were allowed to retain on defense contracts. • • •

Process Instruments and Controls Handbook, edited by Douglas M. Considine, *McGraw-Hill Book Co. Inc.*, 1286 pp., $19.50, 1957.—For engineers and technicians in all industries where instrumentation and automatic controls are important, this book will serve as a review of the principles of many different types of measurement and control processes; a guide to the selection of instruments and automatic controls for specific jobs; and a handy compilation of formulas, constants, and critical and other engineering data for aid in solving instrumentation problems. • • •

Analysis for Production Management, by Edward H. Bowman and Robert B. Fetter, *Richard D. Irwin Inc.*, Homewood, Ill., 495 pp., $7.80, 1957.—This book presents methods of analysis of production management problems based on orientation, mathematical programming, statistical analysis, and economic analysis. Each method is illustrated by a specific manufacturing example to show how theory is related to actual production problems. • • •

Consulting Services, 16th Ed., *Assn. of Consulting Chemists and Chemical Engineers Inc.*, 50 E. 41st St., New York 17, N. Y., 101 pp., 1957.—A directory listing consulting chemists and chemical engineers, both individuals and firms, with details on the qualifications of each, the number on each staff, and the firm's scope and activities. There are also alphabetical listings by name, by geographical location, and by field of activities. • • •

(Continued on page 742)



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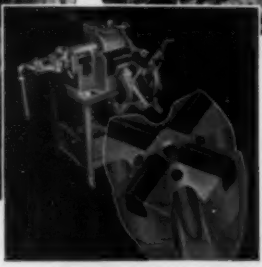

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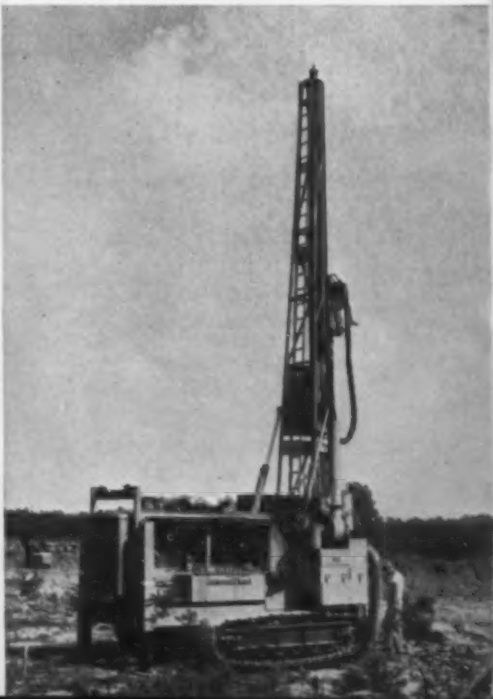

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SEND FOR BULLETINS NO. 4146, 4187

Books

(Continued from page 740)

State Publications

Publications on the Geology and Mineral Resources of Georgia, fifth edition, Circular 1, *Georgia State Div. of Conservation,* Dept. of Mines, Mining & Geology, 19 Hunter St. S. W., Atlanta 3, Ga., 50¢, 1957.

Directory of Georgia Mineral Producers, ninth edition, Circular No. 2, *Georgia State Div. of Conservation,* Dept. of Mines, Mining & Geology, 19 Hunter St. S. W., Atlanta 3, Ga., 50¢, 1956.

58th Annual Report of the Mining Industry of Idaho for 1957, *The State of Idaho,* Office of George A. McDowell, Inspector of Mines, Boise, Idaho, 176 pp., 1957.

Stratigraphic Policy of the Illinois State Geological Survey, by H. B. Willman, David H. Swann, and John C. Frye, Circular 249, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 14 pp., 2¢ postage, 1958.

Groundwater Geology in East-Central Illinois, a Preliminary Report, by Lidia F. Selkregg and John P. Kempton, Circular 248, Illinois State Geological Survey and the Illinois State Water Survey, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 36 pp., 8 figs., 3½¢ postage, 1958.

Geology and Mineral Resources of the Beardstown, Glasford, Havana, and Vermont, Quadrangles, by H. R. Wanless, Bulletin 82, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 233 pp., 7 plates, 66 figs., 26 tables, $1.00, 1957.

Conodonts from the Chester Series in the Type Area of Southwestern Illinois, by C. B. Rexroad, Report of Investigation 199, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 43 pp., 21 figs., 4 plates, 1 table, 25¢, 1957.

Chemical Analyses of Illinois Limestones and Dolomites, by J. E. Lamar, Report of Investigation 200, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 33 pp., 2 tables, 25¢, 1957.

Types of Late Cenozoic Gastropods in the Frank Collins Baker Collection, Illinois State Geological Survey, by A. B. Leonard, Report of Investigation 201, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 24 pp., 4 plates, 25¢, 1957.

Vanadium Efflorescence and Its Control by the Use of Fluorspar, by D. L. Deadmore, A. W. Allen, and J. S. Machin, Report of Investigation 202, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 29 pp., 11 figs., 10 tables, 25¢ plus 3½¢ postage, 1957.

Groundwater Geology in South-Central Illinois, by L. F. Selkregg, W. A. Pryor, and J. P. Kempton, Circular 225, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 30 pp., 7 figs., 3¢ postage, 1957.

Weathering of Illinois Coals During Storage, by H. W. Jackman, R. L. Eissler, and F. H. Reed, Circular 227, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 22 pp., 5 figs., 10 tables, appendix, 3¢ postage, 1957.

Refraction Seismic Investigations, Rosiclare Fluorspar District, Illinois; Part I—Goose Creek Area, by R. B. Johnson, Circular 231, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 15 pp., 7 figs., 2¢ postage, 1957.

Groundwater Geology in Western Illinois, South Part, by R. E. Bergstrom and A. J. Zeizel, Circular 232, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 28 pp., 7 figs., 3¢ postage, 1957.

Microscopy of the Resin Rodlets of Illinois, by R. M. Kosanke and J. A. Harrison, Circular 234, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 16 pp., 4 plates, 2¢ postage, 1957.

Mineral Production in Illinois in 1956, by W. L. Busch and W. H. Voskuil, Circular 238, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 36 pp., 6 figs., 17 tables, 3¢ postage, 1957.

Variation of Coal Reflectance, by Raymond Siever, Circular 241, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 11 pp., 6 figs., 1 table, 2¢ postage, 1957.

Trace Elements in Illinois Pennsylvania Limestones, by M. E. Ostrom, Circular 243, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 34 pp., 4 figs., 5 tables, 3¢ postage, 1957.

Petrography and Origin of Illinois Nodular Cherts, by D. L. Briggs, Circular 245, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 25 pp., 2 figs., 2 plates, 2 tables, 3¢ postage, 1957.

Influence of Coking Time on Expansion Pressure and Coke Quality, by H. W. Jackman, R. L. Eissler, and R. J. Helfinstine, Circular 246, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 26 pp., 16 figs., 3 tables, appendix, 3¢ postage, 1958.

Chitinozoan Faunule of the Devonian Cedar Valley Formation, by Charles Collison and Alan J. Scott, Circular 247, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 34 pp., 3 plates, 13 text figures, 1 table, 3¢ postage, 1958.

Mineral Industries of Illinois, Edition of 1955, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 1 map, 35¢, 1955.

Biocalcarenites in Some Upper Pennsylvanian Limestones in Illinois, by M. E. Ostrom (Reprint from Illinois Academy of Sciences Transactions, vol. 49, pp. 137-142, 1956), Reprint 1957-B, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Subsurface Glacial Geology at Proposed Effingham Damsite and Its Engineering Implications, by George E. Ekblaw (Reprint from Illinois Academy of Sciences Transactions, vol. 49, pp. 129-132, 1956), *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Mineral Resource Research and Activities of the State Geological Survey, 1955-56, by J. C. Frye (Preprint from Annual Report of the Chief to the Director, 1955-1956), Reprint 1957-F, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Minerology of Some Pennsylvanian Carbonate Rocks of Illinois, by Raymond Siever and H. D. Glass (Reprint from Journal of Sedimentary Petrology, vol. 27, no. 1, 1957), Reprint 1957-H, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Some Basic Industrial Trends and Their Economic Influence on the Bituminous Coal Industry, by H. E. Risser (Reprint from Illinois Engineer, vol. 33, no. 4, 1957), Reprint 1957-J, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Status of Soils in Stratigraphic Nomenclature, by G. M. Richmond and J. C. Frye (Reprint from American Assn. of Petroleum Geologists Bulletin, vol. 41, no. 4, 1957), Reprint 1957-J, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

The System CaO-MnO-CO_2: Solid-Solution and Decomposition Relations, by J. R. Goldsmith and D. L. Graf (Reprint from Geochimica et Cosmochimica Acta, vol. 11, pp. 310-334, 1957), Reprint 1957-K, *Illinois State Geological Survey,* National Resources Bldg., Urbana, Ill.

Controlling Vanadium Efflorescence, by J. S. Machin, A. W. Allen, and D. L. Deadmore (Reprint from Ceramic Age, April 1957), Reprint 1957-L, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Developments in Illinois in 1956, by A. H. Bell and Virginia Kline (Reprint from American Assn. of Petroleum Geologists Bulletin, vol., 41, no. 6, 1957), Reprint 1957-M, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Pennsylvanian Sandstones of the Eastern Interior Coal Basin, by Raymond Siever (Reprint from Journal of Sedimentary Petrology, vol. 27, no. 3, pp. 227-250), Reprint 1957-N, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

A Terrestrial Gastropod Fauna from Farmdale (Pleistocene) Deposits in Northwestern Illinois, by A. Byron Leonard (Reprint from Journal of Paleontology, vol. 31, no. 5, pp. 977-981, 1 plate), Reprint 1957-O, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Fuels and Power in the Iron and Steel Industry, by W. H. Voskuil (Reprint from Illinois Engineer, vol. XXXIII, no. 11, pp. 3-5), Reprint 1957-P, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Mineral Resource Research and Activities of the State Geological Survey, 1956-1957, by John C. Frye (Preprint from Annual Report of the Chief to the Director, 1956-1957), Reprint 1958-A, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Relation Between Lattice Constants and Composition of the Ca-Mg Carbonates, by J. R. Goldsmith and D. L. Graf (Reprint from Journal of American Mineralogist, vol. 43, pp. 84-101, 1958), Reprint 1958-D, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill.

Base Map of Illinois, 16x27 in., published by USGS, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 20¢.

Bedrock Surface of Illinois, Edition of 1957, reprinted from Plate 1, Illinois State Geological Survey Bulletin 73, *Illinois State Geological Survey,* Natural Resources Bldg., Urbana, Ill., 25¢.

A Middle Pennsylvanian Foraminiferal Fauna from Dubois County, Ind., by Joseph St. Jean, Jr., Bulletin 10, *Geological Survey,* Publications Section, Indiana Dept. of Conservation, Indiana University, Bloomington, Ind., $1.75, 1957.

Pennsylvanian Underclays—Potential Bonding Clays for Use in Foundries, by Haydn H. Murray, Report of Progress No. 11, *Indiana Geological Survey,* Publications Section, Indiana Dept. of Conservation, Indiana University, Bloomington, Ind., 27 pp., 6 figs., 6 tables, 50¢, 1957.

Subsurface Stratigraphy of the Salem Limestone and Associated Formations in Indiana, by Arthur P. Pinsak, Bulletin 11, *Geological Survey,* Publications Section, Indiana Dept. of Conservation, Indiana University, Bloomington, Ind., 62 pp., 5 plates, 8 figs., 2 tables, $2.00, 1957.

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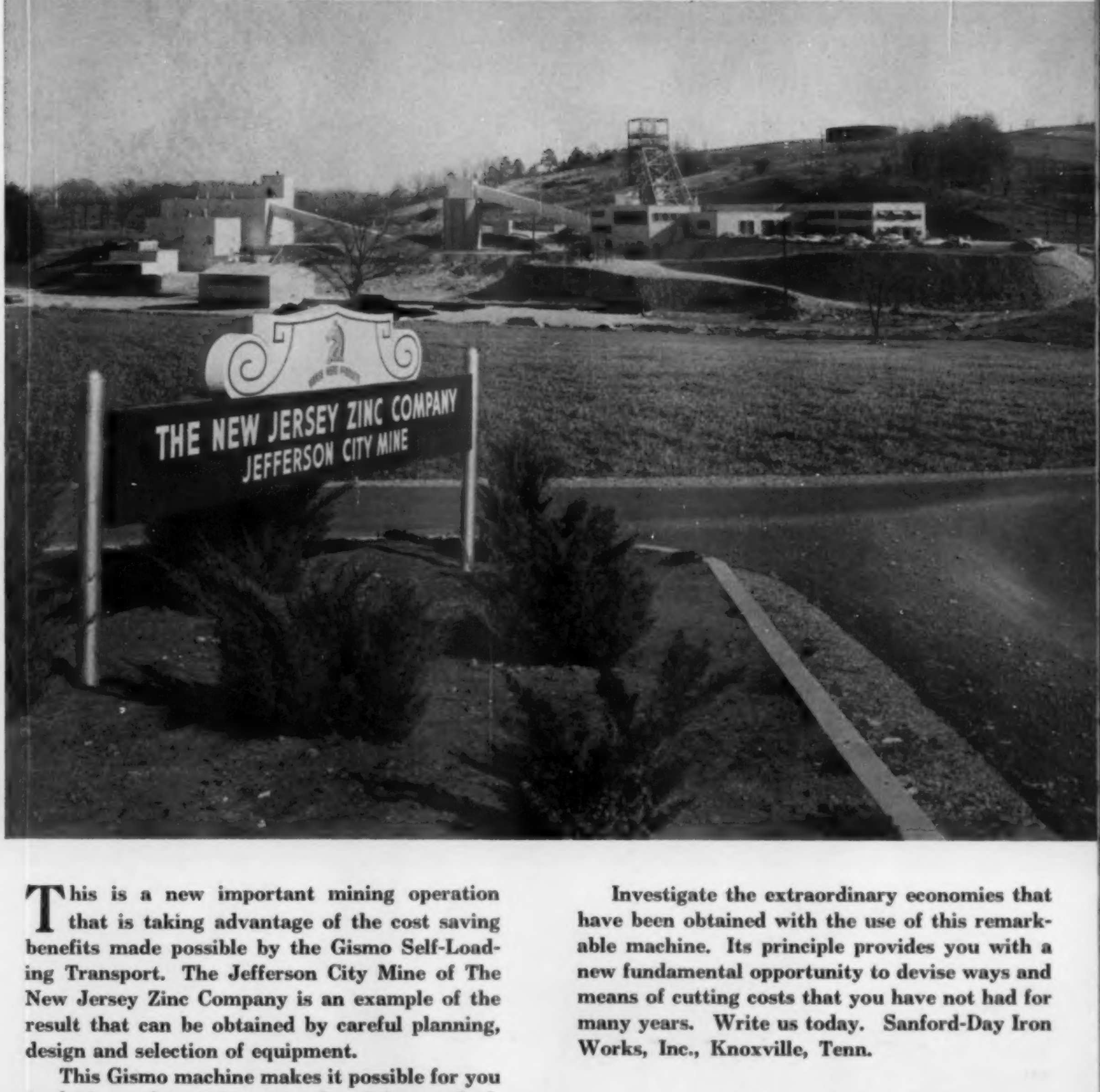
Mineral Trade Notes, Special Supplement No. 52, Refractories Industry in India.

Another Mining Company



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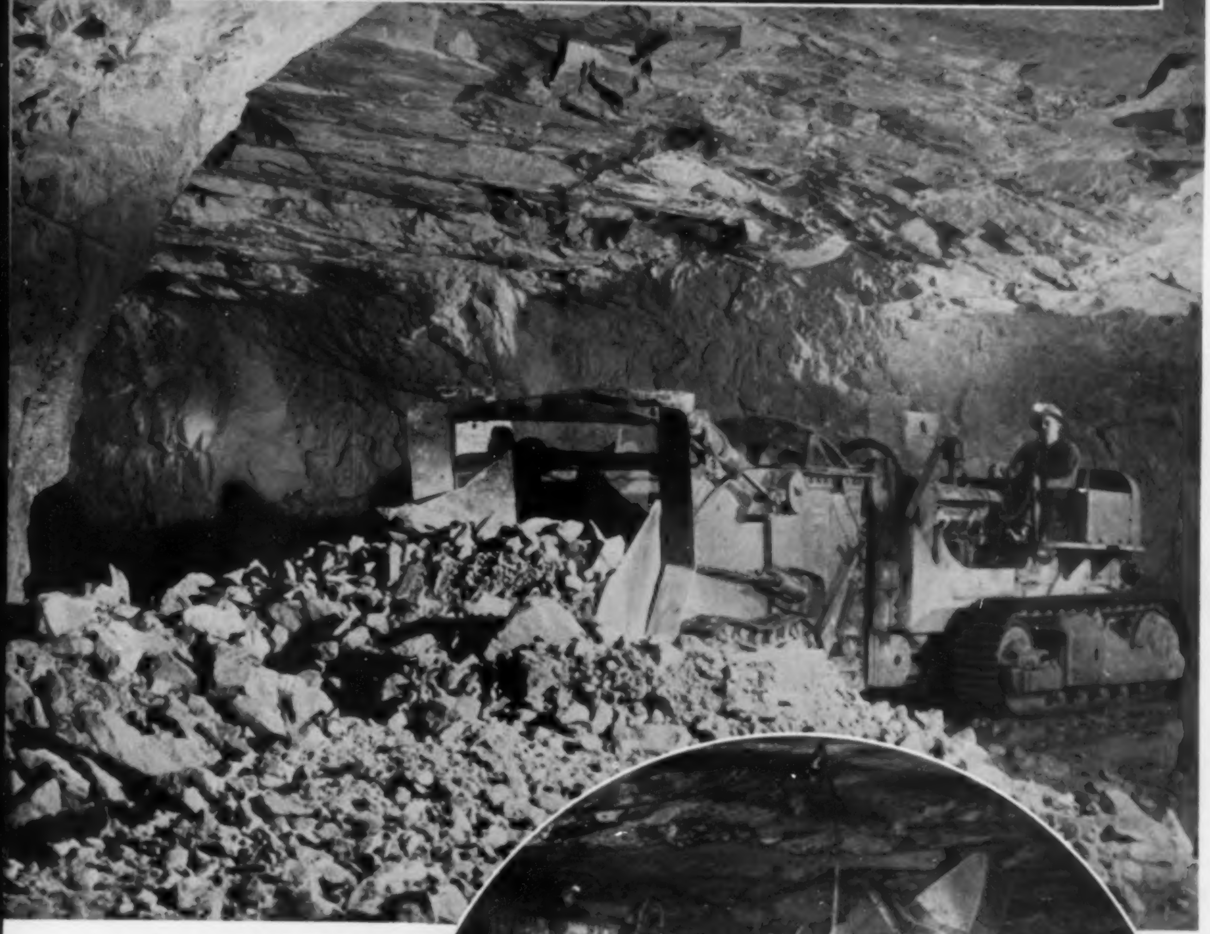


Manufacturers News

News
Equipment
Catalogs

• FILL OUT THE CARD FOR MORE INFORMATION •

Dust Collecting Stoper

A heavy-duty dust collecting stoper, designated S12VT, is offered by *Le Roi Div.*, Westinghouse Air Brake Co. Bit-collected dust and cuttings are drawn through the hollow steel and out through the side of the chuck housing into a Le Roi DK288 dust collector tank. Stoper has telescopic feed and is available in two feed lengths, 34 in. and 52 in. Steel changes are 30 in. and 48 in. **Circle No. 1.**

Alidade

No. 421 designates a precision alidade from *Texas-Asiatic Import Co.* that features complete enclosure of vertical circle and important

parts. Pedestal adjusting screw controls vertical elevation. Unit weighs 5.1 lb—and just over 10 lb with case. Price: $315 complete. **Circle No. 2.**

Mill Load Control

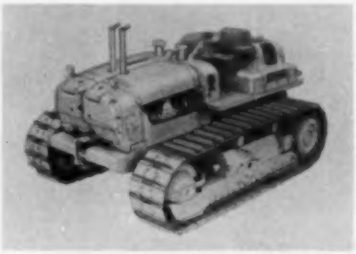
U. S. Electrical Motors Inc. has a new load control system for use on grinding mills or similar equipment. Special advantages offered: no contact with material required; controls are simple, standardized; system is easily installed on existing units; operation is automatic; load level may be varied to meet specific needs. **Circle No. 3.**

Better Grate Magnet

For removing tramp iron from free-flowing materials, a grate magnet by *Stearns Magnetic Products* provides improved collection surface. Magnetic tubes in the Indox grate have continuous poles along their entire length, eliminating dead spots that allow iron particles to slip past. Magnet is available in wing type for hopper or floor installation, and drawer type for closed chutes and ducts. **Circle No. 4.**

Improved Crawler

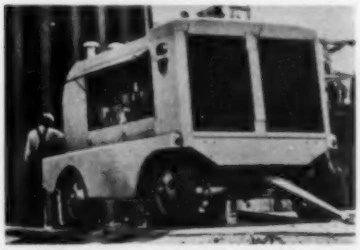
Heavier construction and more rugged components have boosted the weight of the 402-hp *Euclid* TC-12



crawler tractor from 64,000 to 67,000 lb. Some improvements: more durable track shoes, wider self-cleaning links, improved drawbar, 30 pct increase in mechanical advantage of brakes. **Circle No. 5.**

Portable 1200-Cfm Compressor

Le Roi Div., Westinghouse Air Brake Co., believes it has the biggest portable rotary air compressor in its 1200-cfm twin-unit 1200RD2. Each unit can be separately operated to supply 600 cfm, if desired. Unit measures 14 ft 6 in. x 8 ft x 7 ft 11 in. Dry weight is 14,700 lb. **Circle No. 6.**



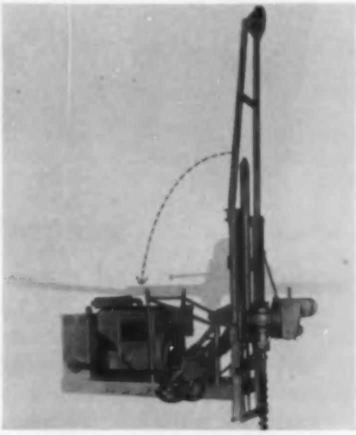
Scraper

LeTourneau-Westinghouse Co. has been converting all of its tractor-drawn scraper models to the easier loading Fullpak design and the last of these is the 11.5 cu yd DT, for use

with tractors of 70+ hp. "Full boiling" action assures a capacity load. List price is $9400 f.o.b. Peoria, Ill. **Circle No. 7.**

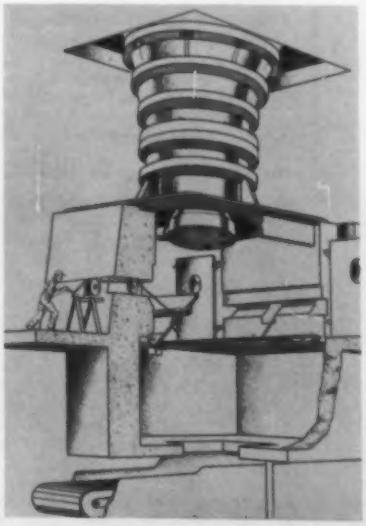
Mobile Drill

Designed for augering, core drilling, and earth boring up to 24-in. diam, the new B-40 Explorer by *Mobile Drilling Inc.* is self-powered by a 4-cyl 36-hp air-cooled engine. Controls are centralized for one-man operation. **Circle No. 8.**



Faster Crusher Maintenance

Allis-Chalmers has devised a retractable working platform to speed gyratory crusher maintenance. Two hinged plates which are folded against the sides of the unit while it operates can be lowered to form a platform for a repair crew when needed. The platform is equipped with rails for an eccentric cart or other service cart and does away with the need for constructing a new work floor when repairs become necessary. **Circle No. 9.**

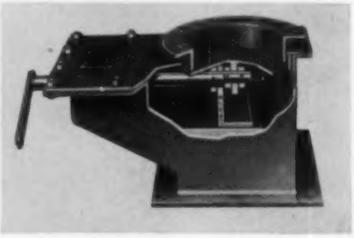


Stoper Feed Leg

Le Roi Div., Westinghouse Air Brake Co., offers an optional larger feed leg for its S10 stoper to give greater pressure in hard rock drilling. New leg is 2⅜-in. diam and features fast leg-drop. Added oiling port gives chuck parts positive lubrication. **Circle No. 10.**

Hopper Valve

A dust-tight but non-sticking slide gate valve is available from *Ducon Co. Inc.* for use on hoppers and storage bins. One-handle operated, the



valve eliminates close-tolerance troubles by use of a cam device which pushes a circular gate into position at the end of the handle throw. **Circle No. 11.**

Hole Cleaning Bit

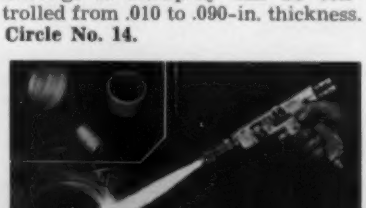
Ingersoll-Rand's Depthmaster down-the-hole drill has been newly redesigned to keep the drill hole clean even when drilling is halted. All operating air is exhausted through the bit, minimizing sticking and prolonging drill life. **Circle No. 12.**

Coal Hauler

Lodestar Corp. offers a new all-aluminum, two compartment bottom hopper dump trailer of 33-cu yd capacity for over-the-road coal haulage. For rigidity, each side panel is formed from a single plate. Trailer weighs 9500 lb and is 35 ft long. **Circle No. 13.**

Spray Hard Surfacing

Kenspray, a hard surfacing powder of high tungsten carbide content, can be applied to irregular steel parts by spraying, announces its developer, *Kennametal Inc.* After coating, the part and its new surface are fused by heating in a furnace or with an oxyacetylene torch. Surface coatings of Kenspray can be controlled from .010 to .090-in. thickness. **Circle No. 14.**



Free Literature

(21) MAGNETIC SEPARATOR: *Carpco Mfg. Inc.* has a new rotating field magnetic separator developed for removal of magnetite and other magnetic materials from dry granular feed. Six, 16, and 36-in. models are offered. Request bulletin RFB-101.

(22) BELT SCALE: Pneu-Weigh, by Omega Machine Co., div. of *B-I-F Industries Inc.*, is a new unit designed to measure and control flow of dry material at low to medium rates from 0 to 3000 lb per min. Featured are positive chain drive to eliminate slippage and continuous integration which totalizes correctly regardless of belt speed.

(23) VIBRATING SCREENS: Features of Low-Head horizontal vibrating screens by *Allis-Chalmers* are described in a new bulletin. Also covered are such auxiliaries as the Sta-Kleen deck used for dry screening moist coal, and the Thermo-Deck used on vibrating screens handling fine, moist materials.

(24) MANGANESE STEELS: *Manganese Steel Forge Co.* has an 8-page bulletin explaining the use of Rol-Man rolled and forged high-manganese steel products throughout the aggregates industries.

(25) REAGENT FEEDER: A new bulletin on the Clarkson feeder Model E in polyvinyl chloride for controlled feeding of acids and other corrosive liquids is offered by *Clarkson Co.* Four-page bulletin 584 supplies data on new materials, design, and performance.

(26) HOT SPOT CONDUIT: Hi-Temp Liquatite flexible wiring conduit for protection of wiring in hot locations is described in a new data sheet from *Electri-Flex Co.*

(27) MATERIAL BLENDING: A 16-page bulletin, B-2, describes *Fuller Co.'s* new Airmerge system for the exact blending of dry pulverized materials.

(28) DRILL STEEL GRINDER: *Atlas Copco* has new leaflet E-864-b which details the new LSB-63 portable drill steel grinder. Powered by compressed air, the new grinder was developed to speed field sharpening of integral drill steels.

(29) OFF-THE-ROAD TIRES: Maximum tire service is the theme of a new 52-page handbook from *B. F. Goodrich Tire Co.* Key factors: load, inflation, operating conditions, and tire care. Complete Goodrich line of off-the-road tires is described.

(30) SETTLING POND CLEAN-UP: A field report, SND 213, from *Sauerman Bros. Inc.* details the use of Sauerman equipment in cleaning settling ponds and reservoirs.

(31) FLOTATION UNIT: *Galigher Co.* has bulletin A55, which supplies details on construction and operation of the Agitair flotation machine. Unit can function as rougher, cleaner, or scavenger in both metallic and non-metallic flotation circuits.

(32) FINE GRINDING: A new bulletin on the *Sturtevant Mill Co.* Micronizer describes fluid energy grinding and gives typical grinding data for various materials. Micronizer is detailed, with a cross-section drawing.

(33) SAFETY LIGHTS & BARRICADES: Catalog LL-6807 from *R. D. Fageol Co.* covers the Fageol Flasher safety light line of battery-powered hazard warning lights, batteries, accessories, and barricades.

(34) MASONRY DRILL: Hercules Core-Cut, a carbide masonry core drill made by *Whitman & Barnes*, is designed to work in concrete, brick, slate, stone, limestone, marble, and similar materials. Available in ½ to 2-in. diam.

(35) BULLDOZER: A 10 ft 8 in. bulldozer for D7 tractors is now available from Caterpillar dealers, announces *Balderson Inc.*, auxiliary equipment manufacturer. U-shaped blade, designated BD7U, has high straight center section and two sides, angling at 25°.

(36) JAW CRUSHER: Twenty-page bulletin 6105 from *Traylor Engineering & Mfg. Co.* is devoted to the features of the Type H primary jaw crusher. On-the-job photos are included with tables, exploded diagrams, and operating instructions.

(37) WELDING CONNECTIONS: Arc welding cable connections and accessories are pictured in a new 12-page catalog from *Tweco Products Inc.*

(38) FIRST AID CABINET: An enameled steel cabinet for storing first aid supplies is offered by *General Scientific Eqpt. Co.* Dimensions: 66x24x12 in.

(39) OUTDOOR MOTORS: *Louis Allis Co.* has a new line of weather-protected motors, designed to operate under extreme conditions. Ratings from 250 to 1500 hp. Ask for bulletin 2550.

MAIL THIS CARD

for more information on items described in Manufacturers News and for bulletins and catalogs listed in the Free Literature section.

7

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51	52	53	54	55	56	57	58	59	60
61	62	63	64						

Students should write direct to manufacturer.

(40) HEAVY DUTY V-BELT: A 4-page bulletin, M210, from Manhattan Rubber Div. of *Raybestos-Manhattan Inc.*, describes a new Condor LS V-belt made for long center, heavy duty drives.

(41) SHAKER CONVEYOR: *Syntron Co.* will supply specifications of a new high-speed shaker conveyor for bulk materials. Fitted with heated or stepped troughs, it will dry, preheat, or cool material in transit.

(42) TRACTOR SHOVEL: A new 8-page catalog, MS-1234, covering the design, engineering, construction, and operating features of the *Allis-Chalmers* HD-6G tractor shovel is now available from the Construction Machinery Div. Included are specifications and a list of interchangeable attachments for increasing the HD-6G's versatility.

(43) BENEFICIATION MACHINERY: Bulletin 574 from *Morse Bros. Machinery Co.* details a complete line of equipment for concentration and flotation of all types of minerals. Typical flowsheet arrangements are included with photos of major Morse units. Amalgam barrels, sand pumps, Jetair flotation machines, rake classifiers, reagent feeders, and filters are among the items covered.

(44) ROTARY DRILLING: *Davey Compressor Co.* has new catalog E-270 describing a line of six standard rotary drills. Included are an an air blast unit, a mud fluid rig, and four combination air compressor-mud pump machines.

(45) EPOXY PIPE: Piping, tubing, and ducting needs of mining operations may be filled with Bondstrand piping manufactured by *Amercoat Corp.* The corrosion-resistant reinforced plastic pipe comes in rigid 20-ft lengths with ends plain, bell-and-spigot, or flanged. Light weight is a feature.

(46) ACID-PROOF SUMP PUMP: Bulletin SP-057 from *Galigher Co.* supplies details on an acid-proof sump pump that effectively handles flotation products, solution transfer, frothy liquids, acid pulps, floor cleanup, and slurries. Models 200 and 300 are designed for heads up to 65 ft, flows up to 250 gpm, and particles up to ¼-in.

(47) ROPEBELT CONVEYOR: Full flexibility is a major feature of the Ropebelt conveyor by *Goodman Mfg. Co.* Catalog G-130 explains how the belt adjusts to increased loads without spillage, permits carrying idler rolls to be in training contact with belt regardless of load, or when belt is empty. Conveyor applies to any bulk material handling, above or below ground.

(48) SPIRAL RAKE THICKENERS: *Denver Eqpt. Co.* bulletin T5-B6 details improved spiral rake thickeners in sizes from 3 to 150-ft diam. Diagrams cover steel, wood, and concrete tanks, and specifications cover all types of service.

(49) COMBUSTIBLE GAS ALARM: The M-S-A Explosilarm by *Mine Safety Appliances Co.* is a self-contained combustible gas alarm featuring minimum first cost, negligible installation cost, and easy maintenance. Unit is intended for installation in non-hazardous areas. Sample line may be up to 100 ft long.

(50) OPTICAL PARTS: *Bausch & Lomb* offers catalog L-117, covering a full line of unmounted optical parts, including lenses, prisms, and reflectors. A price list is included.

(51) LUMBER IN BOX CARS: *Acme Steel Co.* will supply a "Handbook of Instructions for Packaging and Loading Lumber for Shipment in Box Cars." The 28-page manual contains over 50 illustrations and diagrams covering step-by-step procedures in forming a stable carload.

(52) DRIVE BELTS: *Morse Chain Co.* Timing belt-drives mate belt and sprocket with molded belt teeth to match sprocket grooves and so reduce friction and offer positive synchronized drive. Catalog TB-58 has 68 pages of data on five different belt pitches.

(53) SHAKER SCREEN: *Syntron Co.* has a new shaker screen that gives quick scalping and medium to coarse sizing of heavy bulk materials. Screen boxes will handle a variety of surfaces and are adaptable to some dewatering processes.

(54) MINE CAR SUSPENSION: Rubber lends long life and smooth carrying power to a new type of mine car suspension. The development is fully described in a late issue of "Rubber Developments," available from the *Natural Rubber Bureau.*

(55) CHEMICAL CATALOG: Matheson Coleman & Bell Div., *Matheson Co. Inc.* has released a new 162-page catalog listing over 4000 chemical products including new Spectroquality solvents.

(56) TRACTOR: The *International Harvester* TD-14 diesel tractor is detailed in 16-page book CR-630-H.

(57) EXCAVATOR: A 24-page catalog from *Koehring Co.* gives specifications of the Koehring 1205 excavator. High Lift model is equipped with 40-ft boom and 29-ft stick for strip mining.

(58) PROCESS SERVICES: Eight-page bulletin D-1005 from *Kennedy-Van Saun Mfg. & Eng. Corp.* describes the Kennedy test and research center, which specializes in problems in grinding, crushing, calcining, classifying, conveying, and screening.

(59) BOTTOM DUMP: Design features that provide production advantages for the *Allis-Chalmers* TW-360 bottom-dump motor wagon are described in new catalog MS-1269 from the Construction Machinery Div.

(60) DIESEL CRAWLER: *Allis-Chalmers* details operating and engineering features of the HD-6 tractor in 14-page catalog MS-1251. Graphs, charts, cutaway view help explain the workings of this compact unit.

(61) GATE VALVE: The new OPW-Jordan No. 76 gate valve features a 125-psi aluminum body and nylon seating discs, which combine to form a unit whose weight is 40 pct that of a conventional all-bronze gate valve. Nylon discs are claimed to afford tight lasting shut-off even in presence of dirt or grit. Unit is now available in 3-in. screwed-end size. Details in bulletins SRB 20-58 and F-24 from Jordan Industrial Sales Div., *OPW Corp.*

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President

Grinding Mill Bulletin #3

This series of ads on grinding ball rationing of the makeup charge is being presented by CF&I in keeping with our policy "*Not merely to sell; but to serve*". It is our hope that the series will shed some new light on the subject by expressing established principles in practical terms, and that grinding mill operators who are interested in increasing the efficiency and production capacity of their ball mills will find this information of value.

The One-Size Ball Makeup Charge In An Operating Mill

Previous articles in this series have pointed out that determining the optimum size assortment of grinding balls that should be added as a makeup charge is a practical means of improving mill operation; and that the best makeup charge of one-size balls should be established before an attempt is made to work out a rationed makeup charge.

It is better to use oversize rather than undersize balls in the makeup charge. The reason for this is that there is always the possibility of encountering ores that are more difficult to grind. The larger ball would reduce this difficult-to-grind ore, whereas a smaller ball would not. This leaning towards oversize balls is recommended even though they will give fewer contacts and less attrition grinding than a smaller ball.

Indications of Incorrect Ball Size

In a closed circuit mill, a too-small ball size will fail to reduce larger feed particles, and too much tramp oversize will be circulated. Thus, the circuit will become choked, and you will find it necessary to reduce mill feed. With a too-large ball size, coarse particles will be reduced in size, but excessive amounts will need further reduction and excessive slimes may be produced from the impact of large balls. The partially reduced ore particles will overload the classifier, making a reduction in mill feed necessary. Thus both too-small or too-large balls will lower mill production.

In an open circuit mill, balls that are too large do not produce the fineness of grind, or liberation size, required, and they may produce too many slimes. Grinding balls that are too small, on the other hand, permit tramp oversize to enter the next process.

Price May Be Deciding Factor

The 3" diameter steel ball is commonly the lowest-priced ball available whereas small size grinding balls are priced higher. The 3" balls are used most frequently in beneficiation mills and are usually obtainable on an immediate-shipment basis. However, where 3½" and 3" diameter balls give similar results in grinding a particular ore, the 3½" ball may be chosen because of the insurance it provides against the production of tramp oversize should more difficult-to-grind feed ore be encountered later. Nevertheless, the lower price of the 3" ball may be the deciding factor.

Radical Changes are Undesirable

As in other experimental work in an operating circuit, it is good practice not to make too radical a change in the ball size used. Where it is indicated that 4" diameter balls would be more satisfactory than the 3" balls in use, it would be wiser to test 3½" balls first, then check results to prove you are going in the right direction. Or, if it is considered that 2½" balls will improve results as compared with the use of 3" balls, it may be better to substitute 2½" diameter balls for one-quarter or one-half the charge and then check for improvement before using 2½" balls as 100% of the makeup charge.

Whatever the optimum size grinding ball you need for the makeup charge in your operating mill, you'll find it available from CF&I . . . in diameters from ¾" to 5". CF&I grinding balls are forged from special analysis steel and are carefully inspected—throughout production and again immediately prior to shipment—to ensure that they are free of surface pits, circumferential ridges or other surface unevenness. The CF&I representative nearest you will gladly give you complete details.

In the next article in this series, we will discuss general methods of rationing, and the specific steps to be taken in working out a ball ration.

For a reprint of the article on which this ad is based, please write on your company letterhead to: Mining Supply Department, The Colorado Fuel and Iron Corporation, P.O. Box 1920, Denver, Colo.

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6083

Legislative Version of Minerals Support Plan

The Administration has submitted to Congress a somewhat revised version of its five-mineral subsidy plan, added features including a form of price floors, quarterly production limits, payment suspensions if limits are exceeded, and separate company limits in certain cases. The Government will not pay subsidies above the following maximums: Copper, 3½¢ a pound; lead, 3.375¢ a pound; zinc, 2½¢ a pound; acid-grade fluorspar, $8 a short ton; and tungsten (WO_3), $18 a short ton unit. Interior Secretary Fred A. Seaton will have the power to set quarterly limits and, if these limits are exceeded for two successive quarters, to set up individual company quotas for following quarters. The price floors established by the subsidy limitations previously cited would be: Copper, 24¢ a pound; lead, 11.375¢ a pound; zinc, 10¼¢ a pound; fluorspar, $40 a short ton; and tungsten, $18 a short ton unit. Tungsten was set up as a special case. Subsidy payments to any one producer would be limited to 15,000 short ton units per quarter for output from any one mining district. The industry continues to object to the plan on the grounds that payments are not high enough and apportionment of payments among producers has not been clarified. *As this issue goes to press, further revisions have been proposed and the plan remains unsettled.*

Lead Price Drops Again

The ½¢ slash in the price of lead on May 14 was followed by another ½¢ cut on June 3 bringing the metal to the 11¢ a pound level—the lowest since 1950. Lead consumption in the first quarter of the year was down 21 pct from the similar period in 1957, and stocks are mounting steadily.

Sluggish Boats on Lakes

The worst case of doldrums in 20 years has hit the iron ore fleet on the Great Lakes. The active boats total about half the registered number, and by the end of May had hauled only about 4 million tons, compared with more than 16 million tons in the same period last year. End-of-April stockpiles at yards and docks were estimated at 47 million tons by the American Iron Ore Assn.—almost double the amount last year. And this huge reserve will tend to keep the ore boats on their present schedules even if the steel production rate makes its hoped-for surge late in the year.

Sulfur Export Company Formed

The two top U. S. sulfur producers, Texas Gulf Sulfur Co. and Freeport Sulphur Co. have formed a jointly-owned subsidiary, Sulphur Export Corp., to manage sales of sulfur by the two companies outside North America. Other firms were invited to join the enterprise.

Green Light on Private Uranium Sales

The AEC has announced that domestic producers of uranium ore and concentrates may sell these materials privately to domestic and foreign consumers, subject to AEC licensing. Hailed by some producers, the move finds others clamoring for greater freedom: End of licenses

for sales and licenses for mill construction. Canadian producers were recently also given Government permission for private sales—up to 250 lb of metal or its equivalent in U_3O_8.

Extending Jeffrey Mine Open Pit

Canadian Johns-Manville is under way with a two-year program for stripping more than 5 million tons of overburden from the east side of the Jeffrey mine open pit. The extension is expected to extend life of the pit to early 1964.

Freeport to Sell Certain Oil, Gas Properties

Freeport Sulphur Co. has announced it will accept bids on its Lake Washington, La., oil and gas properties. Proceeds of sale of the properties, which amount to two-thirds of the company's oil and gas holdings, would go toward further development of Freeport's sulfur and nickel interests.

Coal-Generated Electricity for Aluminum Plant

The first major aluminum plant to use electric power generated from coal is Kaiser Aluminum & Chemical Co.'s new Ravenswood plant on the Ohio River. Fully integrated recently, the $200-million facility is expected to ultimately produce 300,000 tons of aluminum a year. . . .At another Ohio River site, Ormet Corp. has started up the first of five aluminum reduction furnace lines at a new $110-million plant. Full production, scheduled for year-end, would put 180,000 tons on the market annually.

New Climax Plant

Climax Molybdenum has scheduled initial production for a new $1-million plant for molybdenum metal and alloys in the third quarter of this year. The company says first production will put stress on components for guided missiles.

Asarco Quits Bethlehem Exploration

An agreement covering exploration and development of a copper prospect held by Bethlehem Copper Corp. Ltd., in the Highland Valley of British Columbia has been terminated by American Smelting & Refining Co. Asarco commented that indicated low grade reserves were "not considered sufficiently promising to equip the property for production, or to continue further exploration at the present time." Since mid-1955, the company had spent some $1.2 million on the property.

New Uranium Reserve Data

AEC reports measured, indicated, and inferred domestic reserves of uranium ore totalled 78 million tons at the end of 1957—an increase of 18 million tons over the 1956 total. New Mexico heads the list of states with 53,300 tons averaging 0.26 pct U_3O_8. Domestic ore receipts at all stations in 1957 totalled 3,676,000 dry tons.

Aluminum Can Use Increased by Esso

Esso Standard Oil Co., one of several users of cans fabricated from aluminum, has plans to put its light metal packaging on a larger scale. Its Baltimore plant started using the new containers in May.

Progress of Fund Campaigns Reported For New United Engineering Center

AIME members and industrial companies—including companies supplying equipment—have been responding quickly and generously in the Building Fund campaign for the United Engineering Center.

The approach to industry got under way first, and $3½ million of the $5 million goal had been reached by June 15, with numerous gifts of $25,000 and more, ranging up to $300,000. A tentative target of $100 for each member engineer employed by a company has been set, and this aim has been slightly exceeded in the early returns. The team of Louis S. Cates and H. DeWitt Smith has secured pledges for $600,000 from the nonferrous mining companies, representing 20 pct of total Industry subscriptions to date.

Canvassing of individual engineers, practically all of whom are members of societies that will have a home in the new building, began in the spring. The goal for individual members' subscriptions is $3 million. In the weekly reports of progress made by the different societies, the AIME has consistently ranked at the top—thanks largely to the efforts of H. DeWitt Smith, who took as his assignment the Past-Presidents of the Institute, and other business friends. The 18 living Past-Presidents subscribed a total of $17,395 toward total pledges secured by Mr. Smith for more than $60,000, an excellent start on the AIME quota of $500,000 from its Member Gifts Campaign.

The approach to AIME members in the Mining and Metallurgical Societies has so far been made entirely through the Local Sections. Each Local Section has been asked to submit a list of names of those whom it proposes to canvass personally, and after checking at AIME headquarters to avoid duplications the Section is given the green light to go ahead. Only a limited number of members will be approached at first, as the job will continue for several months. However, by the end of the year it is hoped that all members in the United States will have been approached for a pledge. Thus this is a report of the excellent progress made to date and not an appeal for a pledge.

The pledges may be paid over a three-year period, and may either be in cash or securities if the latter type of payment is more favorable to the payee, income-tax-wise or for other reasons.

A galaxy of the country's outstanding engineers are heading the campaign. Herbert Hoover is Honorary Chairman and Alfred P. Sloan, Jr., Honorary Vice Chairman, with Mervin J. Kelly as General Chairman of The National Industrial Committee. It was Mr. Kelly who headed the group that last year promised adequate financing, which was then expected to be about $2½ million. The sights have since been raised to $8 million of new money, of which the Kelly Committee has agreed to raise $5 million and has already received pledges of over $3 million from industrial concerns. The increased target was set after an exhaustive study of the facilities needed and the best location for a building to be the headquarters of international technology, designed for the advancement of America's engineering leadership. John J. McCloy is Treasurer of the Campaign Fund Committee and the Executive Committee includes Stephen D. Bechtel, Albert Bradley, Louis S. Cates, John L. Collyer, Ralph J. Cordiner, Morse G. Dial, Eugene G. Grace, Henry T. Heald, Roy T. Hurley, James R. Killian, Jr., Donald C. McGraw, and Philip Sporn.

AIME members on the National Industrial Campaign Steering Committee include Donald H. McLaughlin, who is a co-chairman for northern California; Leo F. Reinartz, who is actively soliciting pledges from the steel companies; H. DeWitt Smith, whose work on the Member Campaign has already been mentioned; Will Mitchell, Jr., who is heading the campaign in Wisconsin and Minnesota; William T. Ahlborg, Wayne L. Dowdey, Jack H. How, William B. Stephenson, Carl E. Reistle, Jr., and

(Continued on page 756)

United Engineering Center

(Continued from page 754)

Herbert A. White, who is spearheading the industrial campaign in Illinois.

Inasmuch as the $10 million United Engineering Center will be in New York, campaign committees have been especially active there and a substantial part of both the industry and members' quotas will be raised locally. The Greater New York Business Campaign is headed by William H. Byrne as Chairman, with Mayor Robert F. Wagner as Honorary Chairman, and AIME President Kinzel as an active member of the committee. State committees will get to work in the fall.

As already mentioned, AIME Local Sections are so far responsible for success in the Members' Gifts Campaign. Each has been assigned a tentative quota for early solicitation. Joseph L. Gillson is heading the work, with Michael L. Haider as Vice Chairman for Petroleum, O. B. J. Fraser as Vice Chairman for Metallurgy, and Evan Just as Vice Chairman for Mining. Edward H. Robie is acting as Secretary for the AIME Members' Gifts Campaign with an office at AIME headquarters.

The site for the new building extends from 47th to 48th Sts. on First Avenue, facing the United Nations Plaza and just out of the congested midtown area. Old buildings have been demonlished and construction of the new Center will start shortly, to be completed for occupancy in 1960. Headquarters will be provided not only for the Founder Societies, which now include AIChE as well as the AIME, ASCE, ASME, and AIEE, but for many other societies of which the following have shown an interest: The American Inst. of Consulting Engineers, The American Inst. of Industrial Engineers, American Rocket Soc., American Soc. of Heating and Air-Conditioning Engineers, American Soc. of Refrigerating Engineers, American Water Works Assn., American Welding Soc., Electrochemical Soc., Illuminating Engineering Soc., Soc. of Motion Picture and Television Engineers, American Standards Assn., and Engineering Foundation.

The building will be 20 stories high, and contain about 250,000 sq ft of floor space, for administrative headquarters, publication facilities, meeting and conference rooms, displays and exhibits, and centralized service areas for coordinating such activities as duplication, addressing, and mailing, to assume greater efficiency and economy. The 50-year-old Engineering Societies Building on 39th St. in New York is now in the heart of the wholesale millinery district and is completely outmoded and inadequate for present needs. In planning the new building it was decided to make it one of which all engineers would be proud for the next half century.

A model of the new United Engineering Center was displayed in May when the Greater New York Business Campaign for funds for the center got under way. Admiring the clean lines of the proposed engineering building are, left to right, John J. Theobold, deputy mayor; Richard C. Patterson, New York commissioner of the Dept. of Commerce and Public Events; William H. Byrne, chairman of the Greater New York Business Campaign; Robert F. Wagner, mayor; Abe Stark, president of the City Council; and C. F. Preusse, city administrator.

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Special-alloy reversible tips *(easy to reverse)* nearly double tooth digging life...

In quarry work, in cold and hot slag pits... in the roughest of digging tests, these new Amsco® 2-part Simplex teeth have outlasted competitive 2-part teeth more than 2 to 1... at a big saving in tip and adapter replacement time.

You get this longer wearing quality because of the special, rugged alloy used for both tip and adapter. Reversing tips extends digging life even more, yet takes only a few minutes.

Adapters outlast several sets of tips, are equally easy to replace. Pin lock between tip and adapter seats and locks so securely, metal-to-metal, that even side blows can't jar it loose.

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Today the results speak for themselves. Hundreds of repeat orders from customers who have learned through their own experience — that the statement "You can't beat an Eimco" is a true fact.

An Eimco 630, similar to the machine pictured above, has loaded more than 375,000 tons at a verified average cost for maintenance of only 2.9 cents per ton loaded.

Yes! This is the type of heavy-duty equipment you get from Eimco — this is the equipment to buy to meet low metal prices and show a profit.

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B-229

Enigma in the Steel Works

The exact nature of the blast-furnace transformation of iron ore and the other required ingredients of a furnace charge into iron, slag waste, and gases has long been as unexplained as many another, supposedly simple, everyday process. Textbooks used to tell you the process went like this:

$$Fe_2O_3 + 3C = 2Fe + 3CO$$

Now theorists break it down into progressive reductions, but no one knows precisely the order of chemical transformations of each ingredient.

How long this unhappy state of affairs will be permitted to exist may be up to a busy group of U. S. Steel Corp. scientists. The team, working in Pittsburgh with an experimental blast furnace used by the U. S. Bureau of Mines, stopped the entire furnace cold in the middle of a conversion process. Cooperating with the Bureau and representatives of Linde Air Products Co., they suddenly introduced a blast of nitrogen through the furnace tuyeres to quench its blazing contents. After cooling, which took two weeks, the process of removing the material was begun. The loose contents were withdrawn in the form of 3000 6-in. cubes and the remaining solid contents were core drilled to obtain 20 3-in. diam samples.

Sample analysis will not be completed for some time and just what the experiment will turn up is not known, although a few preliminary observations have been made. Feed materials after being charged into the furnace, for instance, descend in layers and remain relatively unchanged until they reach the smelting zone. In addition, coke has been found to be distributed throughout the layers of metal and slag.

The researchers also hope to learn the mechanism of ore reduction as it takes place in various areas of the furnace, the process of sulfur transfer, and the dimensions and exact location of the fusion zone.

Consider the Sahara . . .

And after you brush aside the visions of smoky-skinned maidens, scimitars, and rubies as big as the eyes of a tiger, your workaday nature will probably settle on thoughts of that huge desert's great oil reserves. But the desolate Sahara can boast of greater mineral wealth than oil alone, according to some impressive geological findings. Coal, salt, manganese, and lead are some of the minerals so far commercially produced in the area's fringe, which comprises most of the hard rock reserves, and a good number of other minerals have been indicated in commercial quantities.

The Sahara is enormous—covering about 3½ million sq miles—and only about one-fifth its area has been seriously explored. Climatic difficulties have helped keep down its development as have lack of pipelines, railroads, ports, and labor. Other circumstances resisting rapid mineral exploitation have turned up as well. Certain coal-rich areas of the Sahara, for example, have the troublesome narrow seams that prevent mechanization even though tonnage figures cry aloud for commercial development. In one area, reserves total some 2 billion tons but only 100 to 200 million tons lie in seams more than 15 in. thick. Other sections are not similarly troubled but they still must cope with the normal, very sizeable difficulties.

Iron fields of the great desert are an enormous asset, and much of the tonnage is amenable to open pit working. Drilling in one large area, exploration crews found hilly sections composed almost solidly of iron ores. Moreover, a combination of coal and iron reserves make certain sections especially inviting.

And there is much more. Copper, zinc, tin, tungsten, gold, nickel, asbestos, platinum, titanium, zirconium, and even a pinch of diamonds have been found.

Turnabout

The aluminum industry is a gimlet-eyed bird that will swoop down on any new market like a hawk nailing a barnyard chicken.

But some of its competitors from time to time have found that a liberal application of the tired old bromide, "If you can't lick 'em, join 'em," will turn a trick to their advantage. The latest example is the U. S. Steel announcement of a brand new barbed wire and farm fence which they have improved with an aluminum overcoat. The wire, after five years of field testing, shows no sign of deterioration. In use it quickly changes from its silvery manufactured color to one of golden bronze which remains indefinitely. Longer life, new color spell out sales advantages, chortles a U. S. Steel executive.

Taking Stock at White Pine, Nev.

Early this year, Consolidated Coppermines Corp. sold its White Pine County, Nevada, mine holdings to Kennecott Copper Corp. in order to eliminate the long-existing inefficiencies and conflicts brought about by the adjacent holdings of the two companies. In a report to stockholders, excerpted below, Consolidated's president, Chester D. Tripp explained the detailed circumstances.

"In previous reports your attention has been drawn to the relatively low grade of our ore reserves and to the fact that profitable mining requires favorable copper prices. Thus, declining prices weigh heavily on attainable results. From a major domestic producers' price of 36¢ per pound at the beginning of 1957, which reflected a drop from the 1956 high of 46¢, the end of the year found us facing a copper market of 27¢ per pound and even this price was weak and unstable. We had not moved very far into 1958 before such domestic price dropped to 25¢ with world markets appreciably undercutting this figure.

"This serious price deterioration emphasized the always present problem of how to plan for future mining operations in a situation such as ours. For

example, for many years we have availed ourselves, on a cost-plus basis, of the mill and smelter owned by Kennecott Copper Corp., the only other active copper mining company in our district, whose mining claims are contiguous to ours. The mill must run at approximate capacity in order to gain reasonable costs. While our share of the mill intake could be met from present ore producing properties for the time being, it was imperative that stripping operations be started on other proven ore reserves of unfortunately still lower grade, so as to meet the mill requirements in the future. These stripping operations would be very substantial and would involve an expenditure of $1.5 to $2 million before any appreciable amount of ore could be mined and, in view of the very marginal grade of ore, a stable selling price much advanced from the present price of copper would be necessary before this operation could break even, let alone be profitable. Thus, continuance of operations, even on a reduced work week, would have subjected your Company to very heavy operating losses while at the same time depleting ore reserves. Alternatively, suspending operations would involve substantial sums in the way of shutdown or standby expense with ultimate recovery problematical.

"As has been recognized since the inception of mining operations in the Robinson Mining District of Nevada, a single ownership of the mining properties of your Company and of Kennecott would make for a more logical and economical operation. While mining results over the years speak well for the competence of the respective staffs and the coordination between the companies, independent planning has not been possible. While this has been a subject of frequent inter-company discussion in the past, it was not until the last months of 1957 that serious conversations were initiated with Kennecott in an attempt to reach a common ground for negotiation.

"This resulted in the consummation on January 31, 1958, of the sale to Kennecott of all of our physical assets in the District comprising mines, buildings, equipment, and materials, for a cash consideration of $8.4 million."

And At Jack Waite. . .

The lead-zinc-silver mining property of the Jack Waite Mining Co. in the Coeur d'Alene district consists of a series of separate orebodies and, as each is exhausted, it is necessary for exploration crews to delineate new mining areas if the operation is to continue.

Since 1934, and until recently, American Smelting & Refining Co. had a 40-year agreement with the company which called for Asarco to operate the mine and pay Jack Waite 65 pct of the net profits while retaining the remainder. The agreement further provided that when Asarco made unpaid advances, it would receive 65 pct of the profits until its expenses were repaid. The agreement has been unsatisfactory to both companies and decreasingly profitable in recent years, with the result that a new plan has been devised.

The situation was explained by Jack Waite to its stockholders as follows:

"Your management and Asarco, both being dissatisfied with the results of the operation, entered upon negotiations for a new agreement to supercede the present operating agreement. Asarco contended (and seemingly rightfully so) that the terms of the operating agreement are such as to discourage its investment of any substantial sums for exploration and development work and for more efficient equipment. For example, if Asarco were to invest $50,000 for these purposes, it would thereafter receive 65 pct of the net earnings until the investment was repaid, with interest; your Company would receive the remaining 35 pct. However, Asarco's 65 pct would merely be for repayment of the sum which it had invested, with interest. Although Asarco would receive interest on its investment, the situation would be such that, during the period when Asarco's investment was being repaid, it would, in effect, be operating the mine without compensation while your Company was receiving 35 pct of the earnings as profit.

"Asarco also pointed out that there is no provision in the present operating agreement for carrying forward losses of any calendar quarter in computing the operating earnings for subsequent quarters.

"Superficially, all of the foregoing provisions of the present agreement favor your Company but in the long run they have hurt your Company because Asarco has refused to invest substantial sums of money for exploration and development work and for modern equipment. Asarco has not expended money to locate orebodies except as required for short term operations. Not knowing that substantial proven ore reserves exist, Asarco has been reluctant to invest money to make the mine operation more efficient and thereby to increase the output and cut costs. As a result, at the present time the mine operation is an uneconomical one, a situation which your Company and Asarco believe can be corrected if the proper incentive is given to Asarco."

Terms of the plan call for extension of the lease from March 1, 1958 for a period of 99 years. In addition, Asarco will spend a minimum of $100,000 on exploration and development, but will no longer operate under the profit disadvantage outlined above. Instead, Jack Waite will receive 45 pct of the net profits and if working capital is needed, Asarco need not distribute the profits until large enough working capital is accumulated out of net profits.

Timberline Taxis

During 1957, the Geological Survey assigned a helicopter to a large party of geologists mapping in southeastern Alaska. The project personnel were quartered on a power barge, which was anchored as near as possible to the center of operations, and each day they were picked up by their flying arm and carried to field investigation areas. Result: Mapping capacity of the scientists was approximately doubled. While the geologists' time and energy had previously been consumed in climbing for hours each day to timber line through densely forested slopes that supplied little geologic information, the helicopter brought them to areas of good rock exposures in just ten to 15 min.

Effectiveness of the method has led the Survey to award a $100,000 contract for helicopter services during 1958. The contract includes continuation of the work done last year and adds use of a helicopter to advance geologic mapping in part of the Yukon-Koyukuk Cretaceous Basin where petroleum crews are doing development work.

Two helicopters will also help speed up topographic mapping in central and southern Alaska where a few gaps remain in the mile-to-the-inch mapping of the new state's interior.

MINING
engineering

DRIFT

How Long Did You Go to School?

Sometimes *Drift* is impersonal and follows the editorial "we" but this month it is strictly "I" and what follows is personal. I hope your reaction is personal, too.

Last month *ME* featured the panel discussion on Mineral Engineering Education (June, pp. 669-674). Reading through the cross section of opinion my hackles rose at the phrase, ". . . many believe we are approaching or have passed the time when a five-year engineering course is more desirable than the present crowded four-year course."

Like many others I have been constitutionally opposed to the idea of 5-year programs and was still simmering when I read D. H. Yardley's description of Minnesota's 5-year program, one which extends across the whole engineering school. If you feel this way about "five years" I suggest you read the first paragraph on page 672 (*ME* June). In fact I'll make it easy, here is the second part of that paragraph:

> A study showed that the average time for engineering students at Minnesota to complete the four-year course was 4.7 academic years; under the five-year plan the time is approximately 5.2 years. Thus the average student requires only half a year longer to obtain five-year training.

At this point I stopped and counted back. An old transcript from the attic helped. My comprehensive survey base of one person showed: Total semester units 156. Average units per semester 16. To have completed in four years, average 19.5 units required per semester. Recommended, 15 units per semester.

This particular university stated in its catalog that 120 units were required to graduate, and further on the Engineering Dept. indicated that about 132 would do for their B.S. degree. Analysis of the fine type at the back of the catalog would have shown that the required and recommended course list totaled 142 units in the mineral division. But, if one got the least out of step this stretched out to 4½ or 5 years, thanks to the sequence of courses. (And, I don't think this example is isolated). Oh, yes, I was strongly against a five year curriculum, hadn't I graduated from a four-year course? In five years!

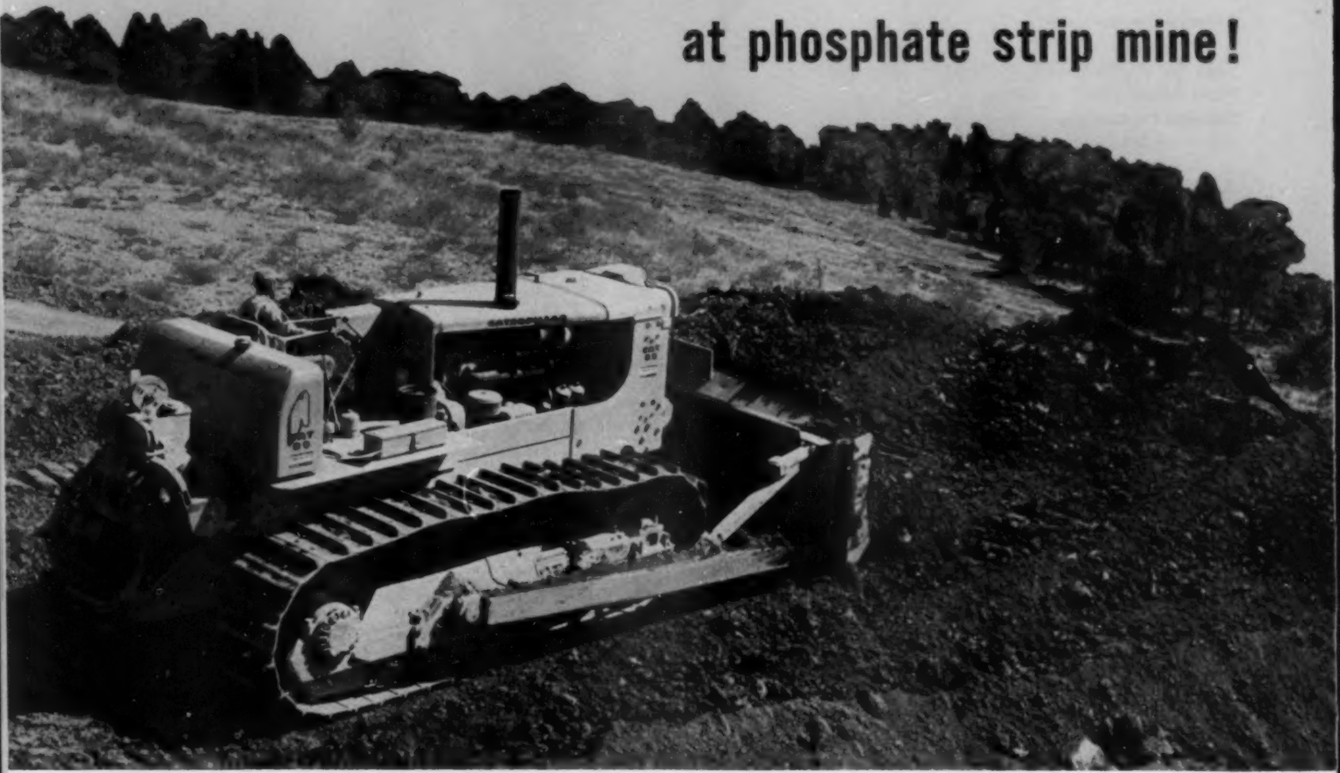
This comprehensive survey was extended over the luncheon table to a broader base, three. After slide rule conversions for interchange of semester and quarter hours, etc., the next two case histories showed 148 and 157 units. Divide by 15 and one arrives at a full five years. One man actually got out in four years, by going to school every summer. The other took parts of seven years.

Two more questions remain. What about garbage courses? The luncheon table poll showed that no one would have willingly eliminated more than six to nine units from what he had taken—but the three of us could list several "musts" that were omitted.

This question remained unanswered: Were all three of us slightly stupid? To go back to the title: How long did *you* go to school?—*R. A. Beals*

D9 DOZES 4,000 CU. YD. OF OVERBURDEN PER 10-HOUR DAY

at phosphate strip mine!



Here's the remarkable record being made by this giant CAT* D9 Tractor with No. 9S Bulldozer on a phosphate strip mine near Columbia, Tennessee:

—Averages 16 cu. yd. per 150-ft. pass dozing overburden to spoil bank.

—Makes 25 passes per hour, working a 10-hour day.

—*Total: 4,000 cu. yd. of overburden moved daily.*

And this king-sized production output is not the whole story. The D9 benches for a 3-yd. Lima dragline—working ahead maintaining a 15 to 18-ft. shelf for dragline footing.

No wonder Malcolm C. West, owner of the mining contracting firm on this operation, says: "You need a volume of overburden to make a profit—and I think the D9 is the only dozer capable of doing the job."

That's the story at mine after mine. When the D9 goes into action, owners wonder how they ever got along without it! Dozing, the D9 can sometimes outwork 2 bulldozers of the next smaller size. With its massive weight and 320 HP at the flywheel, the D9 digs in and pushes bigger loads faster than many new users had believed possible.

Your Caterpillar Dealer is ready to show *you* on your job exactly how the Caterpillar D9 Tractor can give you high production at low cost per yard. And he's ready, too, to stand behind the long life of this dependable machine with prompt, reliable service and parts you can trust.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

WANTED—
THE HARD WORK

Industrial Minerals Used in California's Iron and Steel Industry

Ed. Note: Although the figures here were worked out for California, steelmaking varies little across the country and the percentages are therefore valid in appraising the market for industrial mineral demand anywhere—given the steel production rate and types of production.

by Karl W. Mote

CALIFORNIA'S iron and steel industry had its beginning in San Francisco in 1849 when the first iron casting was poured at the old Union Iron Works. Soon after, in 1856 at Grass Valley, enough iron ore was smelted to supply pig iron for the castings of a quartz mill there. From 1880 to 1886, iron ore was produced from the Hotaling mine in Placer County and converted to pig iron in a local blast furnace using charcoal. From 1907 to 1914, the Noble Electric Steel Co. produced pig iron from iron ore mined at the Shasta Iron Co. mine, and followed this for three years in the production of ferro-alloys.

Between 1917 and 1941, the State's industry increased its capacity for open hearth and electric furnace scrap treatment, but the real impetus was supplied by the need for more steel at the beginning of World War II. The result was the State's first integrated steel plant—the Kaiser Steel Corp. facilities at Fontana.

When production of iron or steel is mentioned, we usually think first of iron ore, scrap and coke. But now, as in 1849, there are many other ingredients essential to the industry. Of these, this paper considers the group called "industrial minerals." The industrial minerals used in iron and steel production are those raw and processed materials which are consumed in steelmaking, but are not added for the purpose of supplying metallics to the finished product, or fuel to carry on the process. By definition, then, iron ore, scrap, coke, manganese ore, and ferro-alloys are excluded.

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The industrial minerals with which this article is concerned, then, are the refractories, fluxes and natural chemicals. In order of total annual cost to the State's industry, these are:

Formed refractories: These are the chief materials in the construction of all furnaces and in the lining of retaining vessels, as well as in the stacks through which the hot gases are handled.

The selection of a refractory for a specific use depends on the chemical environment in which it is to be used—that is, acid, basic or neutral; strength and thermal properties; and, the largest consideration, overall economics of use.

The physical form may be as shapes, or in bulk as described later. The formed refractories can be obtained in any desired shape, and literally hundreds of standard and special shapes are used in steelmaking.

Raw limestone and dolomite: These, especially limestone, provide most of the basic flux in blast furnace iron production, and much of that in open hearth steelmaking. This flux forms slag which is required in removing impurities from the molten

iron and steel. Impurities, normally silica and alumina, should be at a minimum, not exceeding 3 pct.

Burned lime: Used as a basic fluxing additive in the electric and open hearth furnaces to maintain proper slag composition for impurity removal. This is calcium oxide with, normally, no more than 3 pct impurities of silica, alumina and iron, and is prepared by calcining high purity limestone.

Dead, or double, burned dolomite: Used as a refractory, mainly in open hearth furnaces for making up and patching furnace bottoms during furnace operation. This is prepared from calcining raw dolomite at approximately 3000° to form a clinkered product usually having less than 2 pct silica plus alumina, and from 3 to 6 pct iron. The iron is required in the bonding of the material and to help prevent air slaking.

Oxygen: Used throughout the steelmaking processes to oxidize impurities for their removal, to burn off product surface imperfections, to aid in fuel combustion, to burn or melt out tapping holes of furnaces, and others. Oxygen, when used in large amounts, is delivered in liquid form, and gasified immediately prior to use. A relatively new process, the Basic Oxygen Process, is fast making its place in steelmaking, and will result in a considerable increase in oxygen use in the future.

Fluorspar: Used to promote slag fluidity in open hearth and electric furnaces. The chief mineral is fluorite, normally required to compose over 80 pct of the product as consumed.

Dead burned magnesite: Used in steelmaking furnace bottoms and furnace maintenance. This, like dead burned dolomite, is prepared by calcining the raw magnesite stone in kilns or is recovered from sea water and must contain 8 to 14 pct bonding material, chiefly iron, to fuse properly upon heating.

Refractory clays: Clays for bricklaying and various bonding purposes are about the only refractory used in iron and steel production in the raw, finely divided state. The test of usability of clay is in its physical properties, that is, mainly fusion temperature and swelling tendencies, rather than chemical composition. The various uses of clay require a wide range of physical properties.

Pebble lime: Used in the ammonia still in coke byproducts treatment to liberate fixed ammonia.

Foundry sand and silica sand: These are the main ingredients in molds for iron and steel castings, usually mixed with minor additives for proper green strength and shake-out properties. Chemical specifications require the silica content to be over 90 pct with a minimum of carbonates and iron. The physical specifications are extremely important as to the shape of the grains, their size distribution, and their compression strength.

Bentonite: Its primary use is as an additive in sand mold preparation, to give "green" strength to the sand form. This is usually received in a prepared form and purchased according to standardized specifications.

Gilsonite: Is used as a mold coating to repel metal splashes. The material is a natural asphalt, used in ground form.

In addition to the above, other industrial minerals are commonly used in the steel industry, although either not locally applied or applied to a very limited extent. Examples are:

Abrasives for grinding and polishing,

Soda ash for iron desulfurization and surface cleaning,

Hydrated lime as a coating to prevent molten iron from sticking to metal molds,

Salt to provide fluidity to slags to prevent their solidification in ladles, and

Gravel as an acid fluxing agent.

It would be well to note the use of two other necessities in steel production. These are air and water. First, air is an obvious necessity in the processes requiring combustible fuels. Purified oxygen to support combustion has already been mentioned, but an illustration in the use of air will possibly indicate its requirement. The modern blast furnace requires a greater weight of air than all other materials charged to produce one ton of pig iron. These figures are, roughly, two tons of iron ore and other metallic bearing materials, nine-tenths of a ton of coke, four-tenths of a ton of limestone or basic flux, for a total of 3.3 tons of solids charged. The air requirement for these is 3.5 tons, equivalent to the air you normally breathe in 80 days.

Second, water is used for cooling throughout the making and shaping of steel. It has been said that steelmaking facilities are located near an adequate water supply, and that all other materials are transported to that location.

In order to visualize water needs, recent reports in the *Iron and Steel Engineer* indicate water usages of from 1,400 gallons to 65,000 gal per net ton of steel produced. The first figure represents an integrated mill recovering and re-using all water possible, while the second represents a similar mill recovering no water for re-cycling.

Water quality is extremely important also. Total solids and acidity must often be controlled in both first use and re-use of mill water.

The iron and steel industry in California today has the capacity to supply just under 2½ pct of the nation's steel, or nearly 3½ million net ingot tons annually.

The recently released "Iron and Steel" preprint from the U. S. Bureau of Mines Minerals Yearbook for 1955 states that the steel industry annual capacity for the nation is equivalent to 1,550 lb for every man, woman and child.

As stated previously, the present rated capacity of steel producers in California is nearly 3½ million ingot tons. For any expansion of this capacity in the future, whether it be for reasons of forecasted population increases with resultant increased steel demand or for other reasons inherent with a growing economy, industrial minerals should be required in about the present amounts per ton of steel produced.

All this amounts to but one thing for the industrial mineral producer: That is, the growth requirement for the future would indicate a sound position for California in the already growing industrial mineral industry.

References

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Cost of Industrial Minerals Used in Steelmaking

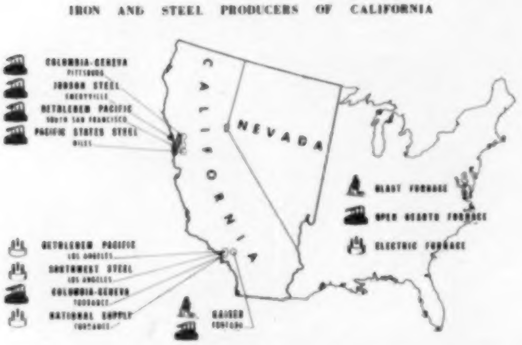


Fig. 1—Operating locations where steel is made. These are:

Bethlehem Pacific Coast Steel Corp. at South San Francisco and Los Angeles
Columbia-Geneva Steel Div. of U. S. Steel, Pittsburgh and Torrance
Judson Steel Corp., Emeryville
Kaiser Steel Corp., Fontana
National Supply Co., Torrance
Pacific States Steel Corp., Niles
Southwest Steel Rolling Mills, Los Angeles

The symbols indicate the type of facilities—whether open hearth, electric furnace, or blast furnace. Note that the only blast furnace plant in operation is at the Kaiser steel plant at Fontana, although a blast furnace is under construction by the Pacific States Steel Corp. at Niles. To define the processes generally, the blast furnace produces pig iron from ore, whereas the open hearth and electric furnaces convert pig iron to steel, or re-refine scrap steel. The relatively new basic oxygen process mentioned before is becoming important in steelmaking and an installation of oxygen furnaces is now in progress at the Kaiser plant at Fontana.

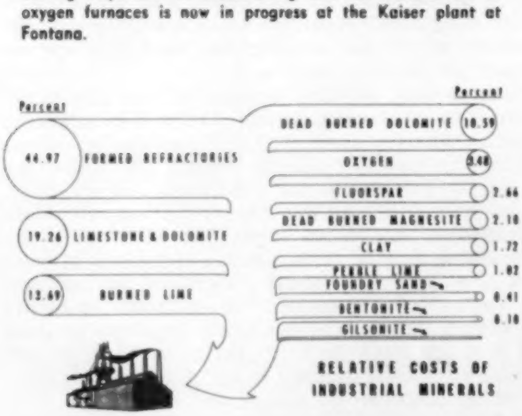


Fig. 2—Relative cost of the industrial minerals used in the State's industry. Note that formed refractories represent almost half of the industrial mineral cost, due to large refractory consumption in the high temperatures required to carry on the steelmaking processes. These, combined with bulk refractories and fluxes, represent approximately 95 pct of the industrial mineral cost.

Fig. 6—Shows a composite of all the industrial minerals used in the State's industry. The greatest weight of any of the industrial minerals used, per net ingot ton of steel produced, is the basic fluxing pair—limestone and dolomite. The relative amounts of materials shown reflect present operations. New facilities, or changes in present practices, would change these relationships. However, these changes will not materially alter the trend of usage. (See right.)

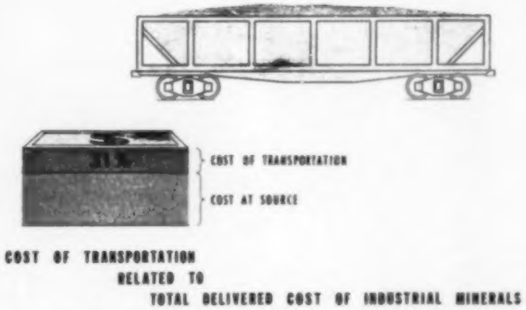


Fig. 3—Transportation costs constitute 31 pct of total cost of industrial minerals in the State's industry. This emphasizes the advantage of sources of quality material near the points of consumption.

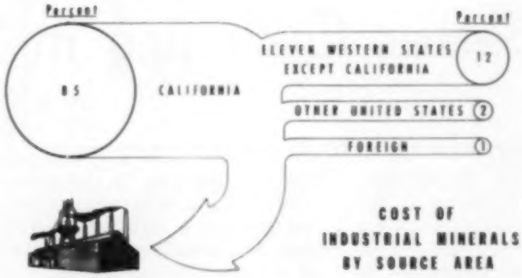


Fig. 4—Distribution of sources of industrial minerals in the State's industry, based on their delivered costs. Note that 85 pct of the State's requirements come from within the State, and only 1 pct from foreign sources.

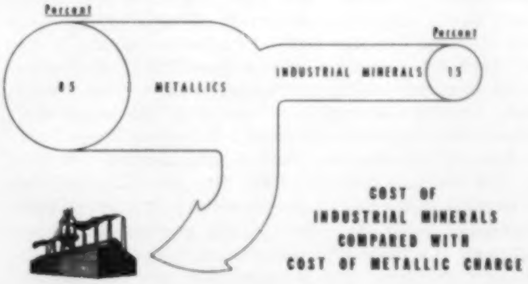
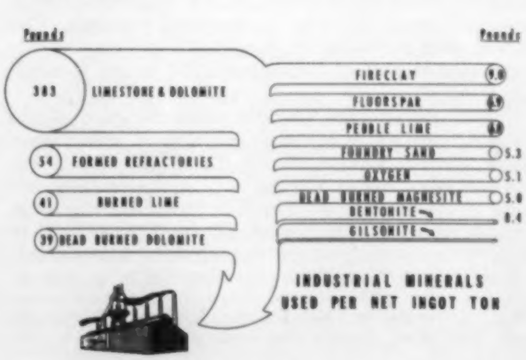


Fig. 5—Industrial mineral cost in California's iron and steel industry is 15 pct of the cost of the total materials charged to the furnaces.



Better Cycloning in Sand-Slime Separation

by R. L. Curfman

WHEN the Uranium Reduction Co. mill was put on stream in October 1956, one of the many operational problems was that the sand-slime separation circuits could not produce a satisfactory RIP feed, inasmuch as production greatly exceeded design capacity.

The original cyclone portion of the circuits consisted of two stages of three 14-in. cyclones in each circuit, as shown in the condensed flowsheet. The high percentage of +325 mesh material in the overflows of these 14-in. cyclones was not consistent with good operation, and flow rates per ton of ore were high, indicating that not enough of the total solids in the ore was being rejected as sands. It was inferred by members of the metallurgical department that returning the underflows, or sand fraction, from these cyclones back into the drag classifiers was the primary reason for dirty feed.

Also, there was frequent agglomeration of resin in the baskets of the RIP circuits. Examination showed that the agglomerates were composed of resin cemented with fine sand. This prevented contact between the resin and the uranium-bearing ion exchange solutions and lowered recovery in the RIP circuits.

To improve these conditions and to increase mill tonnage an improved cycloning system was investigated in which the underflows are rejected directly to tails through a series of washing cyclones. This system was installed in June 1957 in the *A* sand-slime circuit and in December 1957 in the *B* sand-slime circuit.

The units chosen for this revision were Krebs D-10-B and D-6-B cyclones. Each sand-slime separation circuit contains three stages of D-10-B cyclones, five in the first stage, four in the second, and three in the third stage. The RIP feed clean-up stage consists of eight D-6-B cyclones, making a total of 20 cyclones in each of the two circuits. Each circuit is operated by seven pumps, with seven pumps as common standbys between matched operating pumps, making a total of 21 pumps in the two circuits.

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The accompanying condensed flowsheet of the present sand-slime separation circuits reveals that the underflows of any cycloning stage are not returned to drag classifiers, but are subjected to a wash in the pump sumps, where they are mingled with drag classifier overflows in a counter-current system, remaining as underflows until they are rejected as sands to tails.

The cyclone overflow product in each case is returned to a balancing launder in the self-balancing sumps, where a portion of the combined overflows is used to satisfy the pump feeding that stage—the excess is pumped to the preceding drag classifier, thereby maintaining the counter-current movement of solution and barren sands. The RIP feed in the circuits is assured of two stages of cycloning, since the No. 1 drag classifier overflow is cycloned through the first stage of 10-in. cyclones. The overflow from this stage is then fed to the clean-up stage of 6-in. cyclones. In turn, the overflow from this clean-up stage is pumped to RIP as finished feed.

Many problems of design and installation were encountered in setting up 40 new cyclone units with allied piping and pump sumps, installing 9 new pumps, and moving 12 existing pumps in an operating mill—while holding down time to a minimum. These problems were solved, and the *A* circuit was converted and back on stream in 18.5 hr elapsed time. *B* circuit was converted in 15 hr elapsed time.

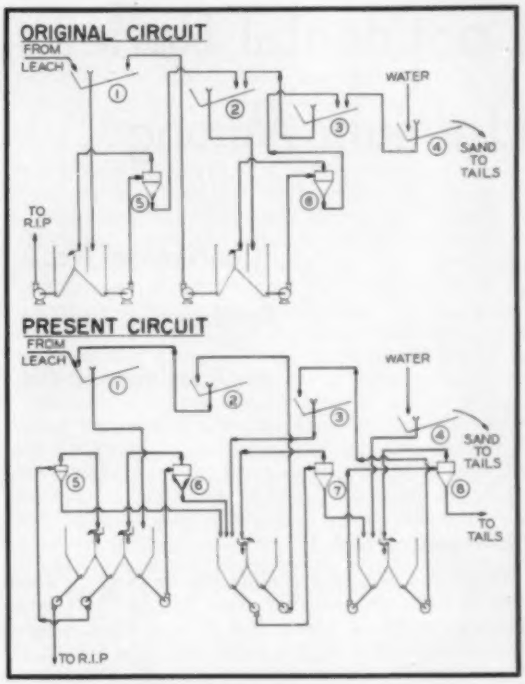
During the period when the two circuits were operating on the different cyclone systems, there was an opportunity to make comparison tests of results effected by the revision.

Tests of the pulp fed to RIP from the converted *A* circuit indicate definite improvement—a composite average of several screen analyses shows a rejection of 99 pct +325 mesh material, compared to rejection of only 91.4 pct +325 mesh material with the original system.

Following conversion of the *A* sand-slime separation circuit, it was often necessary to send part of the RIP feed pulp from the original circuit to the new circuit ahead of RIP in order to keep both circuits operating at maximum and even flow rates. However, pulp from the converted circuit never had to be sent to the original circuit.

From 8:00 am Dec. 9, 1957, to 8:00 am of the following day, the metallurgical department conducted a 24-hr flow rate test to compare the two circuits. This test was conducted under very close control with respect to density of RIP feed pulp; there was no cross-over of pulp; accurate records were kept of cycle time; gallons of RIP feed were accurately measured; and ore split from grinding through leach was critically controlled to assure identical feed to each sand-slime separation circuit. On completion of this test and compilation of results, some very marked differences were evident. The flow rate of the completed *A* circuit was 0.88 gpm per ton of ore per day compared to 1.18 gpm for the original *B* circuit. During this test period each side received 685 dry tons of ore, controlled by reducing tonnage to the grinding section if flow became excessive for either circuit.

The many advantages gained by this revision include savings in water brought about by lower flow rates per ton of ore, savings in reagent costs, increase in RIP recovery, and deletion of part of the maintenance involved in RIP mechanisms and baskets. Probably the most important advantage was increase in milling capacity. Calculation from results of the various tests shows that the mill capacity with the original cyclone circuits was about 1370 tpd compared to a mill capacity with the new circuits of about 1840 tpd when ore of the type used during the test period was treated.



ABOVE: Nos. 1-4 represent Esperanza drag classifiers; No. 5, three 14-in. cyclones; No. 6, three 14-in. cyclones. BELOW: Nos. 1-4, Esperanza drag classifiers; No. 5, RIP feed clean-up, eight 6-in. cyclones; No. 6, first-stage cycloning, five 10-in. cyclones; No. 7, second-stage cycloning, four 10-in. cyclones; No. 8, third-stage cycloning, three 10-in. cyclones.

Discussion

(Ed. Note: The following discussion was condensed from the transcript of the Milling Forum at The Third Uranium Symposium, Moab, Utah).

R. Chelminski (Knowles Associates): I think you should also point out that the original circuit was satisfactory for the ore that you originally anticipated handling.

R. L. Curfman: I am going to have to say "Yes", inasmuch as Mr. Chelminski designed the original circuit. He is absolutely correct.

D. Kentro (Shattuck Denn Mining Co.): This was a slimy ore, wasn't it?

R. L. Curfman: Yes.

G. K. Coates (National Lead Co.): Do you have any figures on your efficiency of wash through the cyclone circuit? What is the soluble loss in final cyclone underflow?

T. F. Izzo (Uranium Reduction Co.): The whole circuit has averaged less than 0.1 pct on the new arrangement.

S. M. Runke (Rare Metals Corp.): We converted our sand-slime separation to the same general design as Uranium Reduction. Our capacity is considerably less than theirs, but the slime fraction of our ore is probably higher than theirs. This made it very difficult to operate the sand-slime circuit with any efficiency. By the simple addition of six 6-in. cyclones to our sand-slime circuit, we have improved it amazingly. We do not have any data on how much we have reduced the amount of slime reporting to our RIP circuit. But, we are now able to operate the washing classifiers without Separan. The new arrangement has improved our operation considerably.

A. Veeder (Anaconda Co.): We have added 24 4-in. D4B cyclone to each circuit, and the best measure of the increased performance is that the water added per ton of ore has decreased from approximately 2.75 volume tons per ton of ore to 2.25. When the volume of solution was at the high figure it was the limiting factor in that our RIP circuit was not able to handle more solution, but by reducing that solution, the limiting factor now has been shifted over to the classifiers being able to get all the sands out. We derived considerable benefit from that.

L. A. Painter: Just one more question that I'd like to direct to Mr. Krebs. Why can't we take all the solids out, why leave any in there?

K. Krebs: That is a question often asked of us. I do not know who first called a cyclone a thickener—it is a complete misnomer. A cyclone always functions as a classifier no matter what terminology may be applied to what it is doing. If we get a call for thickening we tell them to buy a thickener.

Continental Reviews Three Phases of Uranium Mining

Continental No. 1	*Underground*
Rattlesnake Incline	*Underground-Contract*
Rattlesnake Pit	*Open Pit-Stripping*

by J. G. Roscoe and M. H. Brady

Continental No. 1

This mine in Lisbon Valley has an orebody about 1200 ft long and varying from 250 to 70 ft wide. Average width is about 100 ft and stope heights average about 9 ft. It was developed by a 350-ft, 11° inclined shaft for trackless haulage, although a hoist and track are installed for auxiliary hoisting. Mining has been done from horizontal open stopes with random pillar support, using a HD5 tractor for mucking and a 4-wheel drive Gettman shuttle car for tramming. Slushers have been used to some extent in thin ore zones. Back support for stopes and haulage ways has been accomplished by rock bolts and landing mat.

The most interesting feature of this mine has been pillar extraction. Mining was done under contract during the first year of operations with little regard for an orderly plan of stope layout or regularity of openings. Most of this work was done in the largest area of the orebody; consequently, pillar recovery has been accomplished under conditions which are far from ideal. However, a workable system has been developed which is competitive, both in cost and production rate, with open stoping.

Pillar recovery begins in stoped out areas by retreating from the limit of the orebody toward a main haulageway. Whenever possible the retreat is maintained in a straight line across the width of the stope to induce caving and to keep the cave as close as possible to the pillars. This permits trimming of pillars to about an 8-ft diam without taking excessive weight, preventing the cave from jumping pillars as open areas are approached on the retreat.

The method of trimming pillars varies with the size of the pillar and its position relative to adjacent open ground. The first operation is to rock bolt the back if it has not been previously bolted and to stand a double row of 8 to 12-in. posts on about 5-ft centers along the toe of the cave and as close as possible to the leading edge of the pillars.

A very effective timber set was devised by Clarence Cox, the mine foreman, to hold the back in areas where pillars are over 15 ft apart facing the cave. Two 8x8 stringers 8 ft long are rock bolted to the back about 5 ft apart and parallel to the break line. Three caps are placed across the stringers, and the unit is completed with 6 posts blocked and wedged to the caps. These sets are spaced according to conditions encountered, but usually are at least 30 ft apart. They have a high resistance to horizontal thrust and do not kick out of place at the top as single posts often do. Usually they stand until shot out to maintain the break line.

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Upon completion of timbering, extraction of the pillars is started by slabbing and drifting through, depending upon their size. The cave side is drilled while it is still accessible and safe. Approximately 95 pct of the broken pillar is mucked by the HD5, with some clean-up work done by slushing and hand mucking done upon ore blasted into the cave.

The cycle is repeated by bolting the fresh back exposed and continuing with a new line of timber. Occasionally some of the posts must be shot to control the cave, but once the cave has started properly, timber can be placed so that it will hold the back long enough to protect the pillars without excessively delay of caving.

An interesting comparison between open stoping and pillar recovery is shown by the following figures:

	Mining Costs	T/MS	Avg. Mo. Production
Stoping	11.85	5.5	1,500
Pillar recovery	10.30	8.2	1,750

Pillar recovery has been very satisfactory; about 50 tons contained in pillars was lost with no significant amount of ore lost by blasting into the cave. There have been no lost time accidents and very little labor turnover since pillar extraction began.

It is believed that these results are due to the production bonus in effect for the past two years. This family-type bonus is based on pounds of U_3O_8 production per manshift in which the whole working force shares equally. The bonus averages about $15 per manshift per man. This may be criticized as being too high and unreasonable from an efficiency standpoint; however, it is indisputable that since its institution mining costs have decreased about $2 per ton and production has increased 30 pct per manshift; and there is no doubt pillar recovery in this mine could not be as successful without an incentive system.

Rattlesnake Incline

This Continental property is of interest particularly because it is operated under contract to an independent operator. It is an underground mine 27 miles southeast of Moab where a series of small orebodies have been developed by a 21° inclined shaft and conventional track-type mining methods.

The ore consists of carnotite and vanadium minerals occurring in lenses which average about 700 tons in size. Mineralization lies at various horizons in a Salt Wash sandstone member 50 ft thick. Ore varies unpredictably in thickness, grade and continuity. Drilling on 100-ft centers may indicate orebodies as large as 4000 tons or as small as 200.

This mine was started before extensive mining had been done on the Rattlesnake ore trends and drilling information was the prime basis for planning. Therefore, it appeared that contract mining would have certain advantages over a company operation, by eliminating an investment in equipment, by offsetting development costs by contractors incentive and by diminishing the overhead and supervision to economic proportions on a low tonnage production.

The contractor is paid $1.50 per lb of U_3O_8 and 15½¢ per lb of V_2O_5 and furnishes labor, equipment, supplies and tools. The company furnishes track, pipe, timber, ventilation equipment, and engineering services.

Mining is done by slushing to drawholes or ramps to load hand-trammed ore cars which are hoisted to the surface. Stoping proceeds upon the advance with random pillar support. In general, ground conditions are excellent; timber and rock bolts are used only where the back is mudstone or badly fractured.

Clean mining and systematic development are promoted by withholding payment of U_3O_8 above 0.30 and applying that amount to pay for development designated by the company. An excess accumulated above such development cost may be forfeited to the company, so low grade is mined and high grade gouging is automatically discouraged.

Monthly production varies from 300 to 1200 tons, depending upon the amount of development that can be squeezed in with stoping, and that depends largely upon the grade and thickness of ore in current faces. One of the difficulties of this type of operation is in persuading the contractor to pursue development when his labor force is obliged to meet production requirements in a thin narrow stope.

Efficiency in this mine, with its scattered small orebodies, can not be attained by the use of efficient expensive equipment and detailed planning of development work; the size and shape of the ore is too erratic and variable. Here, efficiency is achieved by the contractor's personal appreciation that his production must exceed his mining costs; consequently, he enforces economical application of labor and supplies to get the maximum return for each dollar he spends.

Per ton mining costs at the Rattlesnake Incline can be broken down as follows:

Labor	$4.45
Expenses	2.57
Total	$7.02

Ore production per manshift is 3.7 tons, including development. Mining cost to the company, including development and materials furnished, $14. per ton.

Rattlesnake Pit

This discussion will be concluded with the Rattlesnake pit, the economics of which have been widely discussed.

A review of the reasons behind the decision to develop the ore by stripping is in order, keeping in mind that the pit covered a group of ore lenses similar to those in the Rattlesnake Incline, though concentrated in a smaller area and generally larger in size.

1) At that time Continental contemplated construction of a mill; thus rapid extraction and a high recovery were desirable.

2) An experimental pit in an upfaulted block of ore indicated unfavorable ground conditions and relatively high underground costs.

3) Access would be provided for fringe deposits lying outside the pit perimeter.

This reasoning was based upon experience in Salt Wash mining throughout the Plateau, and subsequently proved to have been sound. These factors have been verified except the mill was not built.

Two and a half million cu yd of overburden were removed under contract; then 180,000 tons of material were mined to recover 70,000 tons of ore, for a stripping ratio of 78 to 1 on a ton-to-ton basis.

Ore was not simply scooped up and shipped as soon as stripping was completed. A waste ratio of nearly 3 to 1 remained above and among the ore after stripping. This required careful grade and mining control to keep production up and dilution down, while achieving acceptable mining costs. The nature of this deposit is not adaptable to bulk mining as in large pits where weekly production exceeds the total Rattlesnake reserve. Consequently, mining costs depend upon the selectivity that can be practiced by equipment large enough to meet production requirements.

Production amounted to an average of 52 tons of material per manshift or 20 tons of ore, to give a direct cost of 88½¢ per ton. To this add 64½¢ for indirect costs and overhead for a total of $1.53. Converted to costs per ton of ore recovered this amounts to a total extraction cost of $3.95.

Development costs, drilling and stripping (capital cost)	$11.80 per ton
Plant and equipment (capital cost)	1.46
Extraction cost	3.95
Total	$17.21
Value of Ore	$23.25
Indicated profit before royalty, depletion, and corporate taxes	$ 6.04

On the basis of our experience it would still appear preferable to strip the Rattlesnake if it were to be done again, but a maximum strip ratio of about 10 to 1 would be desired.

ECPD Accredited Mineral Engineering Colleges

As a service to its readers, MINING ENGINEERING is publishing the mineral industry portion of the 1957 list of *Accredited Undergraduate Engineering Curricula in the United States.* This list, revised annually, is issued by the Education Committee of the Engineers Council for Professional Development, and covers all phases of engineering education. The AIME is actively represented on ECPD, which was jointly organized by the Founder Societies and various other groups interested in the professional recognition of engineers.

ECPD is merely authorized by its constituent organizations to publish a list of accredited engineering curricula for use as desired by those agencies which require such a list. It has no authority to impose any restrictions or standardizations on schools. *(Date following school refers to year of initial accrediting.)*

Mining Engineering

Alabama, University of
Alaska, University of (includes Geological 5-yr. option) (1941)
Arizona, University of
California, University of (Berkeley)
Colorado School of Mines
Columbia University
Idaho, University of (1938)
Illinois, University of
Kentucky, University of
Lehigh University
Michigan College of Mining and Technology
Minnesota, University of
Missouri School of Mines and Metallurgy (includes Petroleum option, 1941); Mining Geology option (1950)
Montana School of Mines
Nevada, University of
North Dakota, University of
Ohio State University (Mine)
Pennsylvania State University (1938)
Pittsburgh, University of
Stanford University (1952)
Texas Western College (formerly Texas College of Mines and Metallurgy) (1947) (includes option in Mining Geology and Mining)
Utah, University of
Virginia Polytechnic Institute (1948)
Washington, State College of
Washington, University of
West Virginia University
Wisconsin, University of

Ceramic Engineering

Clemson A. and M. College (1955)
Georgia Institute of Technology (1942)
Illinois, University of
Iowa State College (1940)
Missouri School of Mines and Metallurgy
New York State College of Ceramics (at Alfred University)
North Carolina State College
Ohio State University (5-year)
Pennsylvania State University (Ceramics) (1938)
Rutgers University (1949)
Texas, University of (1948)
Virginia Polytechnic Institute (1938)
Washington, University of

Geological Engineering

Alaska, University of (5-year option in Min. E.) (1941)
Arizona, University of (1950)
Colorado School of Mines
Idaho, University of (1950)
Kansas, University of (1954)
Louisiana Polytechnic Institute (1956)
Michigan College of Mining and Technology (1951)
Minnesota, University of (1950)
Montana School of Mines
Oklahoma, University of (1953)
Pittsburgh, University of (1950)
Princeton University (1949)
Saint Louis University (1951)
South Dakota School of Mines (1950)
Texas, A. and M. College of (1949)
Texas Western College (option in Mining) (1956)
Utah, University of (1952)
Washington University (1948)

Geophysical Engineering

Colorado School of Mines (1953)
Lehigh University (option in Mining) (1955)
Saint Louis University (1951)

Metallurgical Engineering

Alabama, University of (1949)
Alaska, University of (1957)
Arizona, University of (1950)
Brooklyn, Polytechnic Institute of (1955)
California, University of (Berkeley)
Carnegie Institute of Technology
Case Institute of Technology
Cincinnati, University of (1948)
Colorado School of Mines
Columbia University
Cornell University (1951)
Detroit, University of (option in Ch. E.)
Drexel Institute of Technology (1953)
Fenn College (1948)
Idaho, University of (Metallurgy) (1938)
Illinois Institute of Technology (1949)
Illinois, University of
Kentucky, University of
Lafayette College
Lehigh University
Massachusetts Institute of Technology (Metallurgy)
Michigan College of Mining and Technology
Michigan State College (1954)
Michigan, University of
Minnesota, University of
Missouri School of Mines and Metallurgy
Montana School of Mines (includes Mineral Dressing) (1955)
Nevada, University of (1955)
New York University (1954)
Notre Dame, University of (Metallurgy) (1942)
Ohio State University
Pennsylvania State University (Metallurgy) (1938)
Pennsylvania, University of (1949)
Pittsburgh, University of
Purdue University (1941)
Rensselaer Polytechnic Institute (1938)
South Dakota School of Mines
Stanford University (1952)
Utah, University of
Virginia Polytechnic Institute (1948)
Washington, State College of
Washington, University of
Wayne State University (1950)
Wisconsin, University of
Yale University (Metallurgy)

Options as Part of Other Accredited Curricula Noted

Detroit, University of (Ch. E.) (1940)
Texas Western College (formerly Texas College of Mines and Metallurgy) (Mining Engineering) (1947)

Air-Operated Clamshell for Sinking Small Shafts

by James W. Lower

IN developing the orebody on lower levels of the Star mine at Burke, Idaho, Hecla Mining Co. is faced with a serious problem in driving raises. Levels are at 200-ft intervals. As a raise is being driven between levels, at points about 70 and 130 ft from the sill, heavy pressure arches develop and the raise becomes extremely hazardous. Eventually, following a blast, caving occurs, making it impossible to recover the raise.

In February 1957 it was decided to attempt sinking a small winze on the vein from the 5500 to the 5700 level. This shaft (winze-raise No. 2) was to be used as a raise prior to stoping. It was assumed, and correctly, that the heavy ground pressure could be controlled by timbering close to the bottom after each advance.

In the beginning there was considerable difficulty in the 5500 level drift, from which No. 2 raise was collared. For headroom purposes only the drift set and repair floor were available; there was not enough space to install a standard bucket dumping arrangement. A detail of the drift revealed a width of less than 8 ft between posts and a total height of only 17 ft from rail to gob pole floor. An attempt to raise in the gob could not be made because of the hazards involved.

New Bucket Dump Proves Simple and Versatile

It became evident that a bucket dump would have to be designed to operate in this limited headroom—one that would act as automatically as possible, yet remain simple and versatile. A rapid operating cycle was desired to facilitate the mucking cycle in the shaft.

No. 2 winze-raise was planned with the long dimension at right angles to the strike of the vein so that the wall plates would reach from hanging wall to footwall. After allowing for the width of the vein and two 18-in. headings, average length of wall plate was about 9 ft. The girts, or dividers, were 4 ft 7 in. This created a small two-compartment shaft with an inside measurement of 4 ft 6 in. by 7 ft 6 in. Framed 12x12-in. wall plates and 6½x10-in. girts were used.

Since the vein has an average 88° dip to the south, the collar set was installed 2° off level.

Installation of Frame: A steel adjustable *A* frame was designed to fit in the repair floor, with each leg on a drift cap near the hanging wall. The apex contained a 19-in. sheave wheel. The frame was anchored with rods and turnbuckles hooked to rock bolts grouted in each wall. The sheave was then adjustable and in no way connected to the repair floor caps. Directly under the *A* frame a 5-ft

J. W. LOWER is a Mining Engineer with Hecla Mining Co., Wallace, Idaho. AIME Pacific Northwest Regional Conference, April 1958.

round was excavated from the hanging wall side of the drift to make room for the hoist. A 15-hp Porter air hoist with a stall limit of 2300 lb was installed in this space.

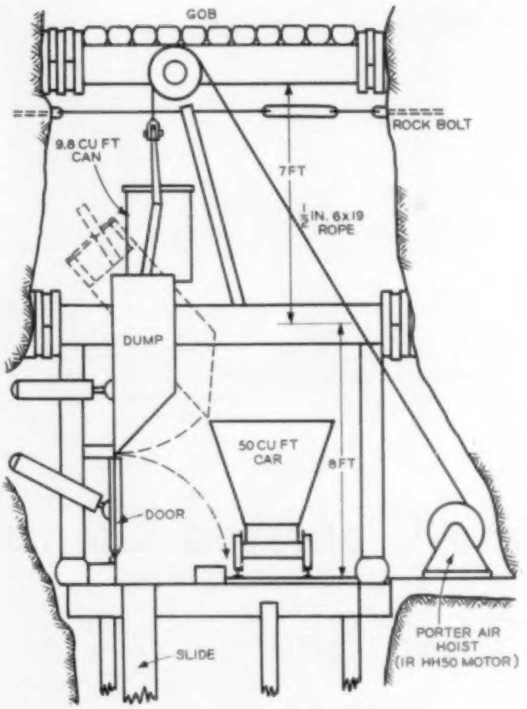
Design of Bucket Dump: The newly designed bucket dump was a hinged steel chute 67 in. long, 30 in. wide, and 24 in. deep. Inclined-channel iron guides were installed inside the chute and extended 30 in. above it. These channels engaged the bucket ears and guided the sinking can into the dumping notches. An air cylinder was bolted to the hanging wall and affixed to the bottom of the dump. A safety door of ¼-in. steel plate was installed over the hoisting compartment to prevent rock spill falling into the shaft when the door was raised.

The cylinders operating the dump and the door were controlled by the hoistman with a four-way Ross valve mounted near the hoist.

The 24-in diam bucket held 9.8 cu ft, struck level. Dumping lugs (or ears) were placed near the bottom and off center to make the bucket tip forward when loaded. A flat runner welded along its back moved on slide boards made possible by the slight incline of the shaft, so that shaft guides could be eliminated.

Operating Cycle: The operating cycle was as follows: 1) Upon receiving the signal from the bottom hoist, the hoistman pulled the can up the shaft and into the dump irons. 2) The hoistman then operated the Ross valve controlling the safety door cylinder. 3) When the safety door closed, it operated a spring-loaded valve that allowed air pressure to actuate the dump cylinder, which forced the dump out over the positioned mine car. 4) With the cable taut and the dump forced out, the unbalance of the can threw its lip forward so that when the hoist brake was released the can emptied its load. 5) After dumping was completed, the Ross valve was reversed. The dump returned to normal position and actuated another spring-loaded valve controlling air to the safety door cylinder. 6) After the safety door was opened, the hoistman raised the can through the notches of the guides and lowered the bucket down the shaft.

This unit proved very satisfactory and substantially shortened the time of the mucking cycle.



New bucket dump is shown for No. 2 winze-raise.

Clamshell Speeds Mucking

As shaft sinking progressed, it became apparent that costs of hand shoveling would be excessive, but none of the equipment manufacturers who were contacted made a clamshell that would operate in such a small rock section. An *orange peel* was investigated that had merit, but past experience with an orange peel in a shaft had been discouraging.

As a suitable machine could not be purchased, the company decided to make one. It was decided to adhere as closely as possible to the jaw design of the Blaw-Knox bucket, which had proved efficient in the Atlas, Radon, and Silver Mountain shafts.

It was desirable that the design of the clamshell meet the following specifications:

1) With the jaws extended, the dimension from tooth point to tooth point should be less that 4 ft 2 in.

2) A low center of gravity was required for safety; therefore the overall height must be as low as possible.

3) The clam should be powered, if possible, to insure efficient digging and operation by a single hoist line. Compressed air should be favored over hydraulic power. An air cylinder appeared most advantageous.

4) The cylinder should be mounted to offer the greatest mechanical advantage.

5) The machine must be simple in construction and easy to operate.

6) Design must minimize the mechanical hazards of operation.

Each side of the jaw was cut from ½-in. AR plate. At both top corners, 1½-in. holes were drilled and bossed. The rear hole accommodated the lever arms, and the hole on the front of the jaw served as the jaw hinge. A curved bottom of ½-in. AR plate was rolled for each jaw. After each side was welded to the bottom, a wear-plate was affixed on the lip and on each side.

A yoke, or platform, was constructed to anchor the cylinder between the jaws. This yoke also acted as a hinge for the jaws.

To gain the maximum crowd at the proper point, a two-way air cylinder was designed with a 17-in. stroke and a 10-in. diam bore. The piston shaft of the cylinder was built of 4140 stock to allay any bending while it was extended. This cylinder was built in the Hecla shops because of its unusual design. It was mounted to the yoke in a vertical position with the piston rod pointing up-

ward. The upper end of the piston rod was screwed to a *T*-shaped headpiece which, with the hoisting clevis, was fastened by one bolt to the upper end of the corner arms. These corner arms were bridged on the sides for additional rigidity and pinned to the outside edge of the jaws in a conventional way.

Loops were welded on the arms near the hinge point of the jaws. A short rope was tied to give positioning control to the operator in the bottom.

Two teeth were bolted to one of the jaws and three teeth to the other jaw. These teeth were made of tempered steel, protruded 6 in. beyond the lip, and were fastened with ¾-in. plow bolts.

All hinge pins were turned and had Alemite grease fittings in the ends. This allowed positive and rapid lubrication.

When fully assembled, the clam weighed about 950 lb. Its height is 4 ft, its width 2 ft 9 in., and its length, extended to full open position, 4 ft 2 in.

Air hoses to the clam were kept taut with a pulley and counterweight farther up in the manway. A four-way hand-operated Ross valve proved satisfactory for control. An HUL Ingersoll-Rand tugger with a 2000-lb rope pull was placed on a platform above the operator in the manway.

Shaft dividers from the tugger down were left out until it was necessary to relocate the tugger. A sheave block was chained to the center of the divider above the tugger, and wire rope was threaded through this to the clamshell. A cross rod was welded to the control valve handle of the tugger—a rope attached to each end of the rod hung within reach of the operator on the floor below.

Operation of Cycle: A 5-ft bench round was blasted in the bottom of the shaft. The can was lowered and placed where it would be out of the way for mucking.

The shaft crew consisted of one man operating the controls and one man positioning the clam on the bottom by means of two ropes. After a team became accustomed to the machine, they quickly achieved efficient control of the mucking operation. It was found that the two bites would normally fill a 9.8-cu ft bucket.

Hecla Got These Results

Several facts were noted after No. 2 winze-raise had been bottomed.

1) In 8 hr it was possible to muck sixty 9.8-cu ft cans and also drill and blast. This permitted 5 ft of advance for each bench.

2) After a depth of 90 ft had been reached, the cycles were timed. It was found that a can could be filled, hoisted, dumped, and lowered in 4½ min.

Design of 4.9-cu ft clamshell resulted in 4-ft overall height, 1 ft 9 in. depth, 4 ft 2 in. jaw opening, and 950 lb gross weight. Air cylinder for crowding is 10-in. diam x 17 in. long.

3) The clam was used for sinking approximately 100 ft of shaft before a raise started from the lower level caved through.

4) There were no mechanical failures at any time during the operation.

5) The clam can be manufacturered commercially or in a small shop for $1000 or less.

6) With this design, it is possible to make a larger or smaller machine by altering the detail sheet.

7) This clamshell should lend itself well to any plan for sinking a small vertical or near-vertical shaft.

8) Although Hecla used a round 24-in. sinking can, it would have been easier to muck and empty the clamshell with a square one. The round skip also handicapped lowering timber and lagging.

Many have asked whether or not the clamshell could be used in an incline shaft. Hecla has not had occasion to use it for this purpose, but probably there would be no insurmountable difficulty on an incline steeper than 65°.

Using an air cylinder in place of cable for crowding the machine offered many advantages, including particularly the positive digging action developed and the speed of dumping.

One action peculiar to the machine was that by laying the machine on its side the operator on the bottom was able to make the lower jaw inactive and use the upper jaw to clean the corners and sides down.

Owing to the soft, faulted, and gougy bottom, on several occasions the operators proceeded as much as 2½ ft below the blast.

It is interesting to note that during most of the mucking cycle the water in the bottom of the shaft was quite deep.

The Hecla shaft sinking operation required one man on the bottom, one to operate the clamshell control in the manway above, one hoistman, and a part-time motorman to pull trains when necessary.

Two of these men had worked on previous shaft sinking operations. Both were enthusiastic in recommending the machine.

Open Pit or Underground, Operators Need

Engineered Blending of Uranium Ores

Although applied here to uranium ores, the basic principles are applicable to any mining situation when the question of where the "assay wall" lies must be answered.

by Edwin T. Wood

THE term *blending* as used herein refers to the mixing of ores assaying more than 0.20 pct U_3O_8 with low grade material assaying less than 0.20 pct U_3O_8. Such blending when properly understood and controlled will produce more total dollars of profit from many mining ventures.

The question whether or not to blend is particularly vexing when an orebody is surrounded by an envelope of low grade material or separate tonnages of low grade exist which could be extracted coincident with the higher grade ores. Should any, all or part of this low grade be mined? If so, in what proportion and what is the limiting assay of the low grade material?

Trial and error solution of various examples will provide specific answers; however, this method is tedious and lacks the desired flexibility for a variety of conditions. The existing price schedule for domestic uranium ores can be summarized into several general blending formulas. These are presented in the hope they may be of use to others faced with these problems.

The general rule may be stated:

> Blending will prove profitable if the product of the blended tons times the profit margin per ton at the blended grade exceeds the product of the higher grade tonnage only times the profit margin per ton on the higher grade ores.

The variables involved in the general statement are: 1) value per ton of the high grade ore, 2) value per ton of the blended grade ore, 3) ratio of the low grade material to the high grade material in the blended mix, and 4) mining cost.

The values per rock ton for ores of various grade under the present domestic price schedule may be expressed by the following formulas:

Material assaying less than 0.20 pct U_3O_8, value per ton = \$400 A^2

Material assaying 0.20 to 0.50 pct U_3O_8, value per ton = \$95 $A - 3.00$

Material assaying more than 0.50 pct U_3O_8, value per ton = \$100 $A - 5.50$

Where A = Assay in percent.

E. T. WOOD is Chief Geological Engineer, Hidden Splendor Mining Co., Salt Lake City. Paper: AIME Uranium Symposium, Moab, Utah, May 1958.

Examples:

0.17 pct U_3O_8 value per ton = (400) $(0.17)^2$ = \$11.56 per ton

0.24 pct U_3O_8 value per ton = $95 \times 0.24 - 3.00$ = \$19.80 per ton

0.65 pct U_3O_8 value per ton = $100 \times 0.65 - 5.50$ = \$59.50 per ton

When two ores are blended, the relative proportions of each may be expressed in terms of the assays of the components and the assay of the mix. Thus, the ratio of low grade tons to high grade tons equals:

$$\frac{\text{Low grade tons}}{\text{High grade tons}} = R = \frac{A_H - A_B}{A_B - A_L}$$

Where A_H = Assay of high grade ore
A_L = Assay of low grade ore
A_B = Assay of blended mix

With regard to mining costs, blending will result in one obvious cost reduction. Fixed capital expense costs per ton will be lowered by reason of the greater tonnage mined. Such fixed dollar expenses would include acquisition costs, exploration, plant, development, and a large portion of the equipment required. The reduction in these capital costs per ton mined may be expressed as follows:

$$\text{Reduction in cost per ton} = \frac{C}{T}\,\frac{(R)}{(1+R)}$$

Where C = Total fixed dollar investment
T = Tons of high grade ore
R = Ratio of low grade tons blended with each ton of high grade ore $= \dfrac{A_H - A_B}{A_B - A_L}$

A further cost saving may be introduced if it is desirable, with the existing plant, to exploit the greater tonnage of blended ore in the same period of time scheduled for extraction of the high grade only. Such increased production rate would lower fixed administrative and overhead costs per ton. This can be expressed as follows:

$$\text{Reduction in cost per ton} = \frac{GFE}{T}\left(\frac{R}{1+R}\right)$$

Where GFE = General fixed administrative cost in dollars.

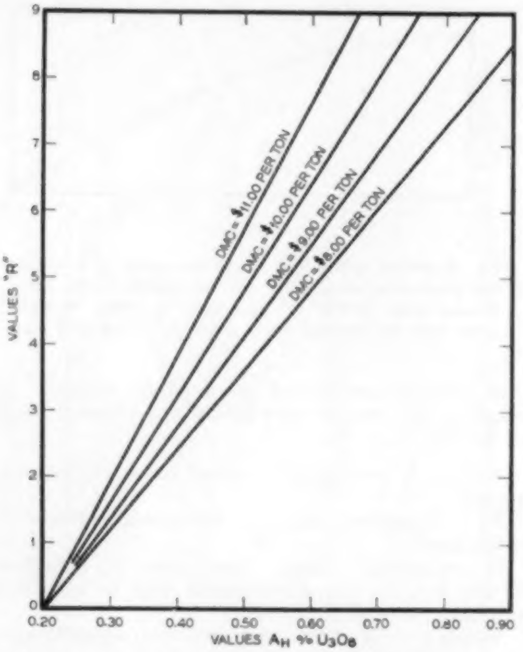


Fig. 1—Blending is profitable only for values of "R" to left of *DMC* or direct mining cost line. Assay of blend is 0.20 pct U_3O_8. Note that equation changes for values of high grade ore above 0.50 pct (see text).

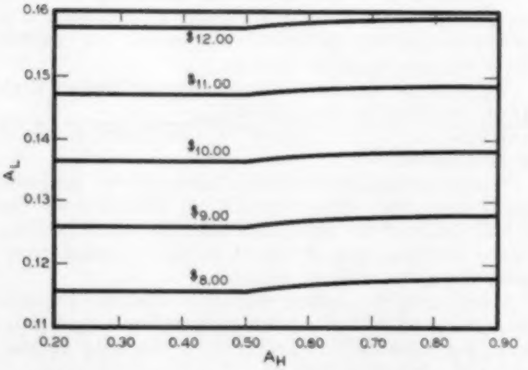


Fig. 2—Minimum values of low grade ore that can be blended to 0.20 pct U_3O_8 at mining costs shown.

Referring back to the general statement which fixed the point at which blending would prove profitable, and using the relationships since developed, the statement may be expressed mathematically as follows:

$$T(1+R)\left[\,95\,A_B - 3.00 - \left(TMC - \frac{C}{T}\cdot\frac{R}{1+R}\right)\right] \geqq$$
$$T(95\,A_H - 3.00 - TMC)$$

Where TMC = total mining cost for high grade tons only, and

$\frac{C}{T}\left(\frac{R}{1+R}\right)$ = reduction in capital costs per ton

by reason of greater tonnage, and $95\,A_B - 3.00$ and $95\,A_H - 3.00$ are the value per ton of the blended grade and higher grade ores respectively, where $A_H = 0.20$ to 0.50 pct U_3O_8.

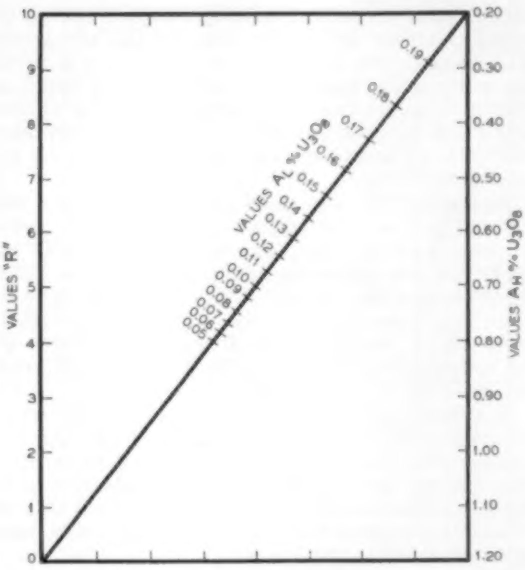


Fig. 3—Graph of $R = \dfrac{A_H - 0.20}{0.20 - A_L}$

Other factors such as income from haulage allowance, special mill premiums, or royalties can be readily substituted in the general equation.

It should be noted, when ore grade material above 0.50 pct U_3O_8 is considered for blending, the right side of the equation must be modified to read $T\,(100\,A_H - 5.50)$.

The general equation can be reduced to express the additional dollars in favor of blending for each ton of high grade ore blended as follows:

$$95\,A_B\,(1+R) - 95\,A_H - R\,(TMC - \frac{C}{T} + 3.00) = 0$$

The expression $\left(TMC - \frac{C}{T}\right)$ is in effect the direct mining cost including administrative costs, inasmuch as the capital expense costs per ton have been subtracted.

If increased production were considered as previously explained, the cost per ton used in equation would be further reduced by the fixed administrative and overhead costs per ton.

For simplification the expression *DMC* is substituted for $\left(TMC - \frac{C}{T}\right)$.

The total additional dollars to be gained by blending, as compared to the mining of the high grade only, is obtained by multiplying the answer derived from the equation by T, the total number of high grade tons available for blending.

It can be shown by the equation that with specific grades of ore available for blending the maximum additional dollars to be gained by blending is realized at a blended grade of 0.20 pct U_3O_8.

Using a blended grade of 0.20 pct U_3O_8, the formula can be equated to zero and blending curves plotted to show the break-even point at different

mining costs for various assays of high grade A_H in terms of either "R" or the assay of the low grade A_L. These curves are shown in Figs. 1 and 2. With the assay of the high grade known and the value of "R" determined from the curve, the assay of the low grade is readily obtained from the nomograph in Fig. 3. Or knowing A_H and A_L, "R" can be determined from Fig. 3.

Example: The following examples illustrate the use of Figs. 1 to 3. Assume the available high grade to assay 0.40 pct U_3O_8, and the mining cost to be \$8.00 per ton including administrative costs. The break-even value of "R" is determined to be 2.37 from Fig. 1, and consequently A_L to be 0.115 pct U_3O_8 from Fig. 3. Or using Fig. 2, this cut-off value of A_L is determined directly to be 0.115 pct U_3O_8, and the ratio "R", 2.37, is obtained from Fig. 3.

In other words, if 2.37 tons of 0.115 pct U_3O_8 were mined and blended with one ton of 0.40 pct U_3O_8 the same dollar income would be realized as mining only the one ton of 0.40 pct U_3O_8. If, however, low grade material assaying more than 0.115 pct U_3O_8 is available, blending will return a greater profit than mining the high grade alone.

For any specific high grade assay, the total dollars gained by blending increases as the value of A_L or "R" increase from the break-even point.

The accompanying Fig. 5 can be used to calculate the additional dollars gained by blending one ton of high grade between the limits of 0.20 and 0.50 pct U_3O_8 with various grades of ore under 0.20 pct U_3O_8. The total dollars to be gained by blending any specific orebody is obtained by multiplying the dollars read from the graph by the tons of high grade ore in the orebody.

Example: Blending one ton of 0.40 pct U_3O_8 with 5 tons of 0.16 pct U_3O_8 will return additional dollars ranging from \$21.00 down to \$1.00 per ton of high grade as the mining cost increases from \$8.00 to \$12.00 per ton. It should be noted that the actual value per ton of 0.16 pct U_3O_8 by itself is only \$10.24.

As the assay of the lowgrade increases, the value per ton may reach a point equal to or greater than the mining cost. At this point such material could be mined without blending. However, by blending to 0.20 pct U_3O_8 income from such ores would be increased, though the margin favoring blending is considerably less dollarwise than the comparison concerning mining high grade only.

The dollars favoring blending such ores per ton of low grade can be expressed by following formulas presuming a blended grade of 0.20 pct U_3O_8.

$$(1)\quad \frac{19.0 + R(16 - 400\,A_L)^{-2} - 95\,A_H}{R}$$

Where $A_H = 0.20 - 0.50$ pct U_3O_8

$$(2)\quad \frac{21.50 + R(16 - 400\,A_L)^{-2} - 100\,A_H}{R}$$

Where $A_H > 0.50$ pct U_3O_8

The previous graphs and formulas have considered only those ores in which the vanadium content was low, and the vanadium payment would normally be waived to offset the lime penalty. When the vanadium content is sufficiently high the effect of blending must be considered on both the vanadium payment and the lime penalty.

Vanadium payment is based on total contained at \$0.31 per lb, thus blending will return more money if there is any vanadium present in the lower grade

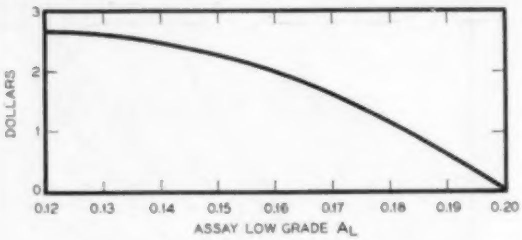


Fig. 4—Dollars gained per ton of low grade by blending low grade ores whose value per ton exceed mining cost. Blended grade is 0.20 pct, and curve is limited to high grade used for blending within limits of 0.20 to 0.50 pct.

ores. The dollars gained in vanadium payment by blending per ton of high grade ore blended equal $(6.20)(R)(V_L)$

Where: R = Original constant based on uranium assays

V_L = Vanadium assay of low grade material to be blended

If the orebody has a fixed ratio of vanadium to uranium the above expression may be rewritten as $(6.20)(r)(A_BR + A_B - A_H)$

Where r = Constant ratio vanadium assay to uranium assay

A_B = Assay blended grade in U_3O_8
A_H = Assay high grade in U_3O_8
A_L = Assay low grade in U_3O_8

If a fixed ratio does not exist, an estimate of the vanadium content of the lower grade ores will probably prove sufficiently accurate to permit blending graphs to be derived.

The change in the lime penalty per ton of high grade ore blended equals $R(0.3\,L_L - 0.8)$

Where $L_L = C_aCO_3$ assay of low grade material to be blended.

Again, unless a fixed ratio between the uranium assay and lime assay exists, an estimate of the C_aCO_3 assay of the low grade material will probably prove sufficiently accurate to graph blending problems from the general equation.

Combining the former equation with the expressions derived for vanadium payment and lime penalty, the total dollars in favor of blending equals:

$$T\,(95A_B\,(1 + R) - 95\,A_H - R\,(3.00 + DMC) +$$
$$T\,(6.20)(R)(V_L) - T\,[R.(0.3\,L_L - 0.8)]$$

It is true that perfect blending of one of more orebodies is an ideal goal, seldom, if ever, attainable. However, profitable blending situations exist which may increase dollar returns manifold. Thus the importance of blending analysis to determine with certainty the combination resulting in the greatest profit cannot be overemphasized.

A general rule can be stated as follows: The maximum dollars will be realized from an orebody when each shipment for payment is blended to 0.20 pct U_3O_8, utilizing all the available low grade, without, however, using any low grade material for blending which falls below the cut-off determined from the formula. If a choice exists between lower grade tonnages available for blending, that with higher assay should be used.

The formulas have been presented purposely in considerable detail to enable the operator to modify them to best suit his particular conditions.

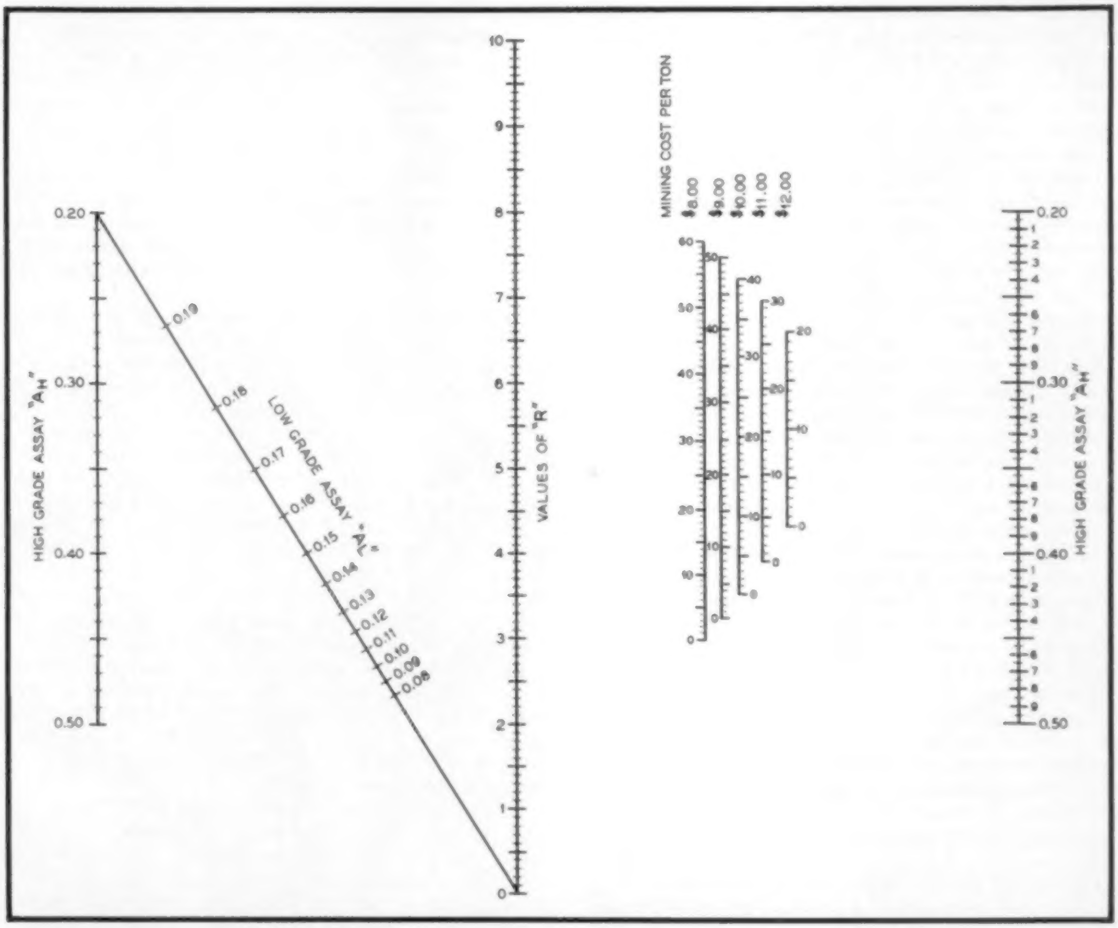


Fig. 5—Additional dollars gained by blending one ton of ore of 0.20 to 0.50 pct with ore below 0.20 pct in grade. Blend assay 0.20 pct. TO USE: Project line connecting A_H on left and A_L to "R". Connect "R" with A_H on right and read dollars gained at intersection with appropriate cost scale. These are additional dollars gained by blending as compared to mining the high grade only, and total dollars to be gained are obtained by multiplying figure from graph by total tons of high grade.

Another View of Blending

by S. E. Craig

UPON entering the Uranium Field it was a pleasant surprise to find almost absent two factors that have always been a problem to the lead-zinc miner: 1) milling cost per ton, and 2) transportation cost to the milling site. Another interesting condition was the fixed price for the product. Under such conditions it seems rather simple to calculate the economics of a mining venture when grade and tonnage of a uranium ore deposit is known. That is assuming, of course, there is a market for the ore. It has been quite generally assumed by operators that a guaranteed price carried with it a guaranteed market, a subject about which there has been a great deal of discussion in the past several months.

S. E. CRAIG is Asst. to the President, Jen Inc., Moab, Utah.
Paper: AIME Uranium Symposium, Moab, Utah, May 1958.

The fixed price for uranium in crude ore, calculated to U_3O_8, varies only slightly in value per pound from rather low grade ore to rather high grade ore. It is by taking advantage of this slight variation in price per pound in certain ranges that miners and shippers may increase substantially the monthly returns from ore shipments.

Minimum selling price for your ore to an ore buying station or to a custom mill is set forth in AEC Uranium Circular 5 (Revised 1953) with later modifications. The expiration date of this directive is Mar. 31, 1962. At that time it is understood that the

AEC will have discontinued the purchase of ore, but will in effect control the production through contracts made with the mills. These contracts are expected to carry provisions requiring mills to reserve a given percentage of their capacity for independent producers, but there does not appear to be any way to assure an independent operator that he will have a certain market for his production because there is no way to predict what new discoveries may be made—perhaps of large new reserves—in which event the AEC contracts with the mills will be large enough to absorb only a small part of such tonnage. The price for the ore if you do have a market will be a negotiated contract between the miner and the mill.

Much of the ore shipped today does not technically qualify under the provisions of AEC Circular 5 but it is still the basis for the purchase of most amenable ores by ore buying stations or mills. The AEC has advised that they have been buying ores not described in the Circular for so long that custom had probably made it cover all amenable ores.

To a former operator of a lead-zinc mill this ore purchase schedule seems a bit unrealistic. The AEC haulage allowance is the same for a ton of ore containing 4 lb U_3O_8 as it is for a ton of ore containing 20 lb U_3O_8. At 6¢ per ton mile for 100 miles for the 0.20 pct ore the cost to the AEC for haulage is $1.50 per lb. For the 1 pct ore the cost is 30¢ per lb.

Also within a mill where the treatment cost is $15 per ton of ore this cost in the case of the 0.20 pct ore is $3.75 per lb and in the case of the 1 pct ore the treatment is 75¢ per lb U_3O_8. There is, undoubtedly, a difference in recovery for the different grade ores. It would appear that the miner with high grade ore might be in a favored position after 1962.

The author has no brief against the provisions of Circular 5. It was part of a crash program to stimulate the discovery and production of uranium ores in this country and it has done its work well. It is the purpose here to point out one or two basic spots where the shipper may use the ore purchase schedule of Circular 5 to his advantage.

Let us look briefly at the schedule. Minimum grade of ore to be delivered is listed at 0.10 pct U_3O_8. That is, rock containing less than 2 lb U_3O_8 per ton is not considered ore. It might be well to mention, however, that most of the imported concentrates procured by the AEC—and these have exceeded 50 pct of their total procurement—comes from ore sources not more than 0.02 pct U_3O_8; and although the ore bodies are comparatively enormous they are paid a higher price to compensate for the lower grade.

A development allowance of 50¢ per pound U_3O_8 is granted on all ores of 0.10 pct and over. The basic price per pound starts at $1.50 for 0.10 pct ore and grades up to $3.50 per lb for 0.20 pct ore and remains at that price for all higher grades. However, there is a bonus of 75¢ per lb for all U_3O_8 above 4 lb per ton and an additional bonus of 25¢ per lb for all U_3O_8 over 10 lb per ton. The various total prices per pound are listed in the table. The price varies from $4.00 per lb for ore of 0.20 pct grade to $4.72 per lb for ore of 1.00 pct grade.

From mining costs and knowledge of the selling price one can readily calculate the cut-off grade in stoping. In development, drifts sometimes produce a considerable quantity of muck carrying some U_3O_8 values. Suppose this muck runs 0.05 pct U_3O_8, and it is already out of the mine as a result of development. Suppose that from stoping 0.30 pct ore is produced. The development muck, as is, is worth nothing; the 0.30 pct ore is worth $25.50 per ton. If 1 ton of the 0.05 pct development muck is mixed with 2 tons of the 0.30 pct ore the resulting 3 tons of ore assay 0.2166 pct with a total value of $52.73 as against $51.00 for the 2 tons of 0.30 pct ore. Thus with low haulage costs there may be an additional return on development muck of $1.73 per ton.

Returns are not quite so good when the ore is above 0.50 pct grade for the blend, because of the extra 25¢ per pound bonus for U_3O_8 in excess of 10 lb per ton. If 2 tons of 0.05 pct ore are mixed with 1 ton of 0.80 pct there is a return of only $1.00 per ton for development muck.

In calculating the cut-off grade for stoping in underground mines one must, of course, consider direct mining costs. Let us consider that 0.12 pct U_3O_8 is a possible grade for the Big Indian District. Mixing a ton of 0.12 pct with a ton of 0.30 pct yields 2 tons of 0.21 pct ore with a total value of $33.90. The one ton of 0.30 pct ore had a value of $25.50. Thus the ton of 0.12 pct ore has a value of $8.40.

The above discussion might indicate that diluting the ore by taking some waste underground was not particularly costly. Indeed, if this dilution assayed 0.05 pct it might even appear to have value. However, one must remember mining costs will have to be charged against this dilution and in some mines this cost is quite substantial. Further, as is shown by the above data, transportation and other costs make excessive dilution in some degree an overall economic waste.

Table I

Grade	Lbs U_3O_8	Price Per Pound	Price Per Ton	75¢/Lb Over 4 Lbs	25¢/Lb Over 10 Lbs	Devel.	Per Ton	Per Pound
0.10	2	$1.50	$ 3.00	$	$	$ 1.00	$ 4.00	$2.00
0.15	3	2.50	7.50			1.50	9.00	3.00
0.20	4	3.50	14.00			2.00	16.00	4.00
0.25	5	3.50	17.50	0.75		2.50	20.75	4.15
0.30	6	3.50	21.00	1.50		3.00	25.50	4.25
0.35	7	3.50	24.50	2.25		3.50	30.25	4.32
0.40	8	3.50	28.00	3.00		4.00	35.00	4.37
0.45	9	3.50	31.50	3.75		4.50	39.75	4.42
0.50	10	3.50	35.00	4.50		5.00	44.50	4.45
0.55	11	3.50	38.50	5.25	0.25	5.50	49.50	4.50
0.60	12	3.50	42.00	6.00	0.50	6.00	54.50	4.54
0.65	13	3.50	45.50	6.75	0.75	6.50	59.50	4.57
0.70	14	3.50	49.00	7.50	1.00	7.00	64.50	4.61
0.75	15	3.50	52.50	8.25	1.25	7.50	69.50	4.64
0.80	16	3.50	56.00	9.00	1.50	8.00	74.50	4.66
0.85	17	3.50	59.50	9.75	1.75	8.50	79.50	4.66
0.90	18	3.50	63.00	10.50	2.00	9.00	84.50	4.70
0.95	19	3.50	66.50	11.25	2.25	9.50	89.50	4.71
1.00	20	3.50	70.00	12.00	2.50	10.00	94.50	4.72

Note: This value per pound, or per ton, does not include initial production bonus or haulage allowances.

Significance of Geochemical Distribution Trends in Soil

by D. H. Yardley

GEOCHEMICAL investigation of trace elements in surface materials was begun near Ely, Minn., in 1953 along the basal contact of Duluth gabbro with Giants Range granite (Fig. 1). This article presents data on the distribution of copper and nickel in till and in stream sediments in the area and proposes an explanation for the types of distribution found.

The Duluth gabbro, one of the world's largest basic intrusives, intrudes rocks which range in age from Keewatin to middle Keweenawan. Within the test area the gabbro is in contact with granite except for short sections where it is in contact with remnants of iron formation. Sulfide mineralization occurs within the gabbro, near and parallel to the basal contact for a distance of several miles. Schwartz and Davidson[1] have described the geologic setting of the mineralization.

The sulfides, believed to be syngenetic, include chalcopyrite, cubanite, pentlandite, pyrrhotite, and minor amounts of bornite. They occur disseminated in the silicates and as small interstitial masses. The ratio of copper to nickel is about 3.8:1, based on 66 chemical analyses of rock samples from various outcrops (Ref. 1, p. 702, and Ref. 2).

Test Procedures: With specified exceptions, all nickel and copper tests were made by the chromograph method,[3] which measures the intensity of a colored spot formed by a reaction between the metal being determined and special reagent paper. The intensity is then compared to the intensity of spots prepared from samples of known metal content. Details of the test procedure are outlined in another article (Ref. 4, pp. 77,78).

All soil samples tested in this investigation to date have been weighed on an analytical balance. However, a volumetric scoop designed to provide about 0.1 g of soil adds to the speed and ease of testing and has been found to give satisfactory results (Ref. 5, p. 531, and Ref. 19). The size of the samples used for the tests was 0.1 g. Whenever such small samples are used there is some question as to whether they are representative of the several grams in the field sample. Many repeat tests of the samples used in this investigation demonstrated that results can be reproduced within the limits of accuracy of the method without formal mixing beyond that inherent in screening the soil fractions. Furthermore, the 0.1 g is probably as representative of the field sample as the field sample is of its area of influence. Hawkes and Lakin (Ref. 6, p. 291), who

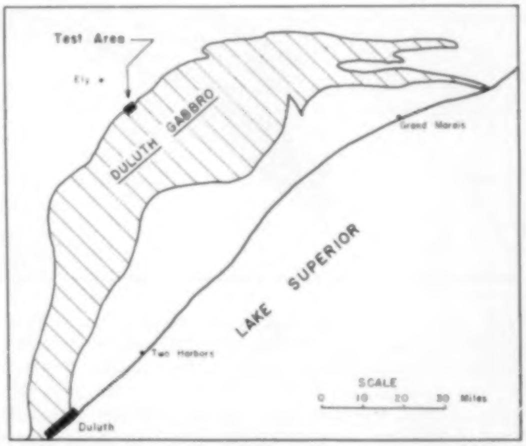


Fig. 1—Index map and outline of Duluth gabbro.

considered the general problem, compared ground and quartered bulk samples of 500 g with 5-g grab samples. They concluded that "there is no significant loss in accuracy of data by substituting grab samples for bulk samples."

The term *soil* implies somewhat different things to the geologist, engineer, and soil scientist.[7] For convenience the term as used in this article refers to unconsolidated material (the mantle) overlying bed rock.

Sampling Procedure: Samples were taken at 100-ft intervals along north-south traverse lines across the gabbro-granite contact. The soil (till) samples were taken at an average depth of 1 ft, which was below the high-humus surface layer and into clean till. Samples taken at 1-ft intervals down to ledge showed as high a metal content at 1 ft below the air-surface as at greater depths and in two instances were slightly higher. The till at 1-ft depth did not appear to differ from material at greater depths. Total depth to bedrock has been tested at only a few points and where measured varied from 1 to 10 ft.

Aerial Distribution Contours and Profiles: Plotting of copper, nickel, and cobalt content in contour form (Fig. 2) shows that anomalous amounts of these metal ions occur in till over and closely adjacent to mineralized areas of the gabbro. Contouring nickel content alone, or the copper content, outlines the same target area. Contours of the copper content provide a more distinct anomaly than nickel because of the higher copper concentration. The traverses are rather widely spread for interpolation; however, drilling has confirmed the target area essentially as shown.

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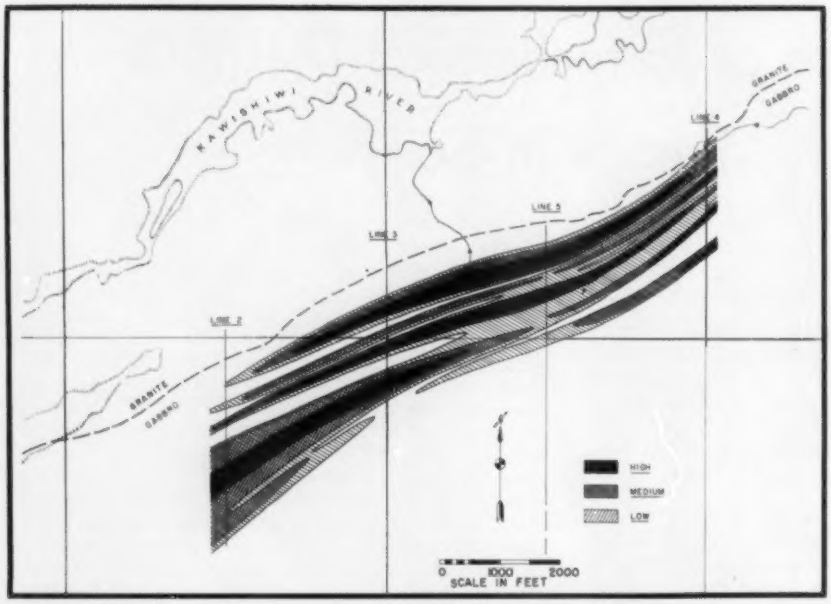

Fig. 2—Contour map of copper, nickel, and cobalt content in glacial till. Ely district, Minnesota.

The position of the northern boundary of the anomaly implies that the mineralization is parallel to, but not quite at the base of the gabbro. This is confirmed by three USBM drillholes.

Distribution by Soil Size: Testing of soil samples for any geochemical campaign involves a decision as to whether the sample should be screened and what soil fraction should be selected for testing if screening is used.

The glacial overburden in the area displays a wide range of particle size. For this reason it was necessary to select the soil fraction most likely to represent the true heavy metal content. The finer soil fractions generally are to be preferred in soil sampling, because sulfides would tend to weather to finer size (Ref. 5, p. 530).

Exceptions to this general rule do occur. Sergeev (Ref. 8, p. 46), comparing the tin, tungsten, and chromium contents of −1 mm fraction with 5 mm and coarser sizes in the part of the geochemical halo nearest the deposit, states: "The content of the valuable elements is approximately the same in both. In places, however, the coarser fraction contains somewhat more of the valuable element. Lean samples (a remote or the train part of the halo) have a lower content of the valuable element (down to zero) in the coarser fraction, although its concentration is stable in the finer fraction. It may be concluded that dispersion takes place chiefly at the expense of the finer materials." And also: "Remembering that halos of saline genesis are characterized by secondary compounds less directly related to the massive rock, the advantages of observing the halos in the fine deluvial fraction become evident. Such samples provide a reliable expression of the dispersion halo in its largest spatial development."

The example cited by Sergeev refers to elements that are resistant to chemical weathering and dominantly residual in nature. Ground-up coarse fractions that contain one or more large pieces of ore mineral would test high in metal, but even those elements which occur in resistant mineral conform to the general rule in the train part of a halo.

A factor that also favors selection of the fine soil fraction, in addition to the tendency of sulfides to weather to finer sizes, is the probability that transportation of heavy metals by capillary solutions may be important in the formation of some geochemical halos, and capillarity would be less effective in coarser materials. Bischoff (Ref. 9, p. 58) provides some indirect support for this view: "Gravel and coarse sand on the contrary proved very unfavorable, probably because of rapid drainage. . . . The depth of favorable overburden through which ground water would bring appreciable quantities of heavy metals to surface was surprising. The practical maximum overburden is now considered to be 30 to 50 feet for clay and 20 to 30 feet for fine sand." Bischoff also noted a blanketing or masking effect of sand and gravel ridges.

Distribution in Soil Fractions: The far greater number of soil particles in a unit weight of fine materials would be much more likely to include some particles of mechanically derived ore mineral than would the coarser fractions. The finer sizes also provide a much larger total surface area and so could absorb more metal ions from percolating soil solutions. Thus the finer materials would tend to *fix* relatively larger amounts of metal ions; it might be said that they have a larger total adsorption capacity and so would be much more likely than the coarse fractions to reflect the presence of anomalous concentrations of trace elements.

Samples were sieved through stainless steel screens to avoid possible contamination by abrasion. All screens used were Tyler screen scale. The +9 mesh material was crushed in an agate mortar before fusion.

Table I compares the metal content of the +9 mesh and −80 mesh fractions from ten samples of till. From these data it can be concluded that for all practical purposes the heavy metals do not occur in the +9 mesh soil size, at least for the concentration ranges shown.

Table II is a comparison of the nickel content of −9+80 mesh and −800 mesh soil fractions. Although the −9+80 mesh fraction contains less nickel, about two thirds as much as the −80 fraction, the anomaly would not be missed by testing only the −9+80 mesh fraction.

Comparison of the nickel content for 30 samples on a parallel traverse showed that the −9+80 fraction averaged 62 pct as high as the −80 fraction. Again the anomaly was obvious using either soil size. It seems reasonable to conclude that mixture of the two sizes (all the −9 mesh material) will give dependable results for many field comparisons.

The preceding figures demonstrate that for most field work the finer soil sizes are more indicative of geochemical anomalies. To confirm this view a study was made of samples of till known to contain appreciable quantities of copper and nickel. The samples were screened to six products and five chromographic analyses were made for nickel and five for copper. Agreement of analytic results was particularly good in the finer size samples. The +9 and −9+32 mesh fractions were crushed in an agate mortar before fusion in both this and later tests. Fig. 3 illustrates the distribution trend.

The notable feature is that there is an increase of metal content with decreasing soil size in the materials coarser than 80 mesh, but for the finer fractions the metal content remains about equal.

Table I. Comparison of Metal Content of +9 Mesh and —80 Mesh Fractions from Ten Samples of Till

	Nickel, Ppm		Copper, Ppm	
	+9 Mesh	−80 Mesh	+9 Mesh	−80 Mesh
	0	0	30	5
	0	5	0	7
	0	15	10	25
	0	250	5	375
	0	100	5	250
	10	100	5	300
	0	120	25	400
	50	160	50	350
	0	70	5	250
	10	10	5	15
Total	70	830	140	1977

Approximately 8 pct Ni and 7 pct Cu detected in +9 mesh fraction (compared to −80 mesh fraction).

The only exception to the trend was one sample of rubble-like material consisting of more than 50 pct of +32 mesh size. In this case the +9 mesh material tested substantially higher than the −9+32 size, but even here the normal trend applied for the fractions smaller than 32 mesh.

Certain general conclusions may be drawn from these tests on till:

1) The −9 mesh material would be satisfactory for most field work, but samples of only −80 mesh material will give more reliable results and are to be preferred where anomalies of small magnitude may be expected.

2) The leveling off of metal content in the sizes smaller than −80 mesh shows that nothing is gained by any attempt to screen to a size finer than 80 mesh.

3) There is no general direct distribution relationship between metal content and available surface area of the finer particles of till. This is significant in any consideration of the processes by which trace elements move and are fixed in soils.

Discussion of Distribution Curve in Till: The amount of metal ion in various soil sizes, if held there by adsorption, should show some relation in its distribution to the total amount of soil-particle surface area available. While this might not be a direct

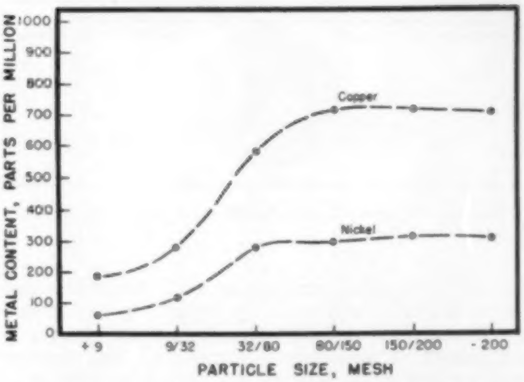

Fig. 3—Copper and nickel distribution trends in soil fractions of till. (Each point on curve represents the arithmetic mean of 28 analyses.)

linear relationship, at least there should be some increase in ion content with the increase in surface area. This reasoning should apply to heavy metals introduced (epigenetic trace elements) into the soil as ions in infiltrating soil solutions. The total content would also include similar ions derived from the nearby source area by mechanical processes (syngenetic trace elements). Here again there should be some increase of the ion in the finer sizes because of the lesser physical resistance of sulfides. Also, later chemical attack by soil solutions on such sulfide particles should help distribute a greater proportion of metal ions where the adsorption capacity is highest.

Theoretically the heavy metal content should increase as the surface area capable of fixing ions increases. The till samples, however, do not show such an increase for material finer than about 80 mesh. Either the reasoning that postulates a continued increase of ion in the finer sizes is incorrect, or some factor or combination of factors interferes with the full development of a theoretical type of distribution. If the reasoning is essentially correct, then soils where the interfering factors are absent should have metal ion contents that do increase as total soil-particle surface increases.

Table II. Comparison of Nickel Content, Ppm, of —80 Mesh Soil Fraction and —9+80 Mesh Fraction, 100-Ft Sample Spacing

	−9+80 Mesh	−80 Mesh
	0	0
	10	20
	0	0
	0	0
	10	0
	300	400
	250	500
	300	300
	75	100
	350	400
	100	150
	70	150
	400	700
	0	75
Total	1865	2795

The following explanation is proposed for the till distribution trend of Fig. 3:

A volume of till made up of some combination of particle sizes has incomplete sorting. It is necessary to visualize a non-homogeneous sample, in which there are portions or zones of dominantly coarse

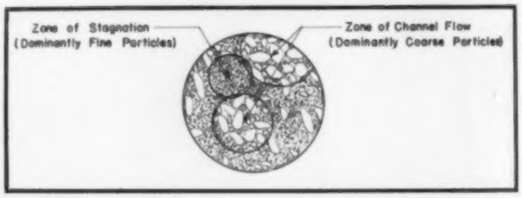

Fig. 4—Diagrammatic representation of zones of channel flow and stagnation.

particles and other portions of dominantly fine particles. Within such zones permeability and interspace sizes will depend directly on the degree of dominance of particular particle sizes, and porosity may depend on it. Assume an instant of time when the postulated mix has just been formed by glacial action. Two extremes of saturation by soil water are possible: 1) complete saturation, probably by water of low trace element content, as time and the chemical environment would hardly favor strong solution effects, and 2) complete absence of soil water, an unlikely situation. In either case the fixed trace elements present at this point would be primarily a product of mechanical weathering.

Next visualize complete or fairly complete saturation of the mix by soil water. Any metal ions present in this water can now be fixed through adsorption by the nearby particle surfaces. There will not be enough metal ions present at this stage to use up the full adsorption capacity of the particles. If stagnant conditions were to prevail at this point the only additional changes in ion distribution would be in the near vicinity of any sulfide particle which could provide ions to the soil solutions and which could migrate locally by various types of diffusion until fixed.

The next stage would be introduction of ion from a nearby source—the epigenetic component of the total heavy metal concentration. It is possible to visualize movement of soil water carrying metal ion in solution. How would a solution move through the mix? The solution would not move as a pervasive migration but would tend to *channel* through the zones of greatest permeability and to bypass zones or volumes of low permeability. Channel flow is a path of preferred flow—a path of higher permeability than the surrounding regions (Fig. 4).

Thus the introduction of additional ions to the mix as solute would be uneven. The soil particles in and adjoining the zones of channelized movement would have access to migrating ions and would be able to make use of their surface adsorption capacity. The soil volumes bypassed by the channelized flow will be those of dominantly finer sizes, of smaller interspaces, of greater resistance to fluid flow. Here conditions would be essentially those of stagnation and the particles within these zones would not have complete access to additional ions. Thus even though the zones of dominantly finer sizes have the greater total surface area and hence the greater adsorption capacity, they are unable to make use of their full potential. As migrating water is introduced into the system it follows a tortuous but continuous channel through the larger interspaces; then smaller channels form as smaller interspaces are invaded. Eventually, an equilibrium will be attained and additional channels will cease to develop. Around and between the channels of flow will be bypassed zones in which original fluid remains unaffected by the migrating soil water. Although the finer particles have the greater adsorption capacity, only a small percent of that capacity is used, while the larger particles with lesser surface capacity use a large percentage of that capacity. The final result is that the soil-fraction distribution of ions within unsorted till does not show a direct relationship to available surface area. Studies made in the Stanolind Oil & Gas Co. laboratories show that movement of solutions through oil sands does channel and that zones of stagnation exist.[10] This laboratory work provides a strong foundation for believing that movement of soil solutions will be similar in nature. It is also important to keep in mind the probability of occurrence of the events described.

The distributional curve (Fig. 3) of till samples begins to flatten at about the 80 mesh soil size. The preceding discussion can account for the flattened portion of the curve. The question arises as to why the curve ceases to rise at that particular size range. Apparently the size near 0.175 mm is a critical size. It is believed that particles below the critical size were largely in the zones of stagnation and those above the critical size were largely in the zones of solution movement. The critical size is the one where the interspaces of the soil mix are so small that they impeded flow of solution. They provide a lower limit of channel flow.

To recapitulate, below a critical particle size (and so of interspace size) the particles are able to use only a small proportion of their large adsorption capacity. Above the critical size the particles use a large proportion of their relatively small adsorption capacity. The curve can thus be explained in terms of the accessability to ions, which in turn is a reflection of the origin and geologic history of the sampled material.

The total content of heavy metal will be made up of ions of mechanical origin and ions introduced later by other processes. The adsorbed metal ions will consist of introduced material from the mineralized source and of redistributed metal ion from local reactions between soil solutions and soil particles containing metal ions. The slope of the distribution curve will depend on the amounts of heavy metal supplied in each way and on the environmental history of the mix. Where zones of fluid migration contain a higher proportion of finer particles the fine soil fractions should have a higher proportion of adsorbed metal ion. The proportion of metal ion of mechanical origin to that of later origin in a particular soil fraction will also affect the curve

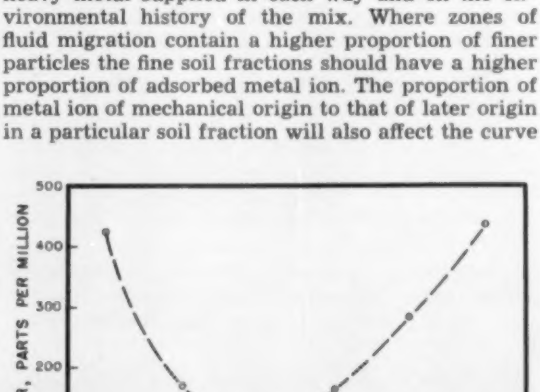

Fig. 5—Copper distribution trend in soil fractions of active stream sediments. (Each point on curve represents the arithmetic mean of 28 analyses.)

slope. It is the interplay of these variables that influences the slope of a distribution curve.

Distribution in Stream Sediments: Any explanation of the distribution curve for till which relates trace elements content to geologic history implies that material that has had a different geologic history should display a somewhat different type of distribution curve. It is known that stream sediments are very useful in geochemical exploration.[11] Stream sediments, if transported by waters containing heavy metals, should contain significant amounts of the metal. The material has had a different geologic history than till because of the exposure to a period of water transport.

The waters of streams draining mineralized terrane may contain several times as much heavy metal as other streams. All soil particles in stream sediment have had a high probability of access to metal ion during their transport as discrete particles. Individual particles of all sizes should have been able to exercise their adsorption capacity to a high degree and should display an increased concentration of ion with increase of available surface area. Some data presented by Hawkes (Ref. 11, p. 1125) suggest that this is actually the case.

Samples of active stream sediments were collected in Fillson Creek near Ely in November 1956 from locations where the stream bed overlies the mineralized zone. The waters of the creek where it crosses the mineralized zone (Fig. 2) contain about 0.025 ppm of heavy metals, as compared to 0.005 ppm in other streams of the district. The samples were dried and screened, and tests were run for copper by the biquinoline method[13] and for both copper and nickel with the chromograph. Composite results of the tests are given in Figs. 5 and 6.

The distribution curve for stream sediments is quite different from that for till. The heavy metal content does not decrease for particle sizes smaller than 80 mesh; it continues to increase. The slope of that part of the distribution curve is of the form predicated from consideration of the channel flow hypothesis presented above.

What appears at first to be a new complication is that the metal content of the coarser particles is also higher than that of the intermediate sizes. Consideration of the particular nature of the samples suggests the following explanation:

Much of the stream bed material is of local origin, particles broken off by glacial action and reworked to some extent by water action. The larger particles in the sample have a low surface to volume ratio and so have not been greatly affected by chemical weathering. Because many of these particles are derived from the mineralized zone, some contain metal as sulfides and in the silicate structures. Fusion and analyses of such samples result in high tests. The intermediate and fine size particles have a higher surface to volume ratio and so are much more subject to attack and breakdown through chemical action. This would be especially true of the sulfides. As the sulfide particles react and disintegrate they supply metal ion to the water. Adsorption of some portion of the heavy metal can now occur and the finer sediment particles would adsorb the greater proportion. Thus the intermediate size particles are impoverished relative to the coarser, while the finer particles increase in heavy metal ion content because of their high adsorption capacity.

The distribution curve of the stream sediments reflects ions of two kinds, largely mechanically de-

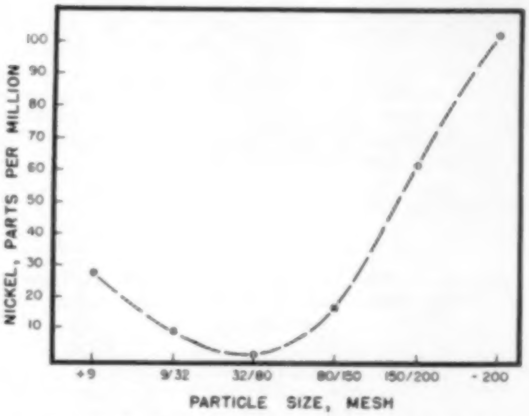

Fig. 6—Nickel distribution trend in soil fractions of active stream sediments. (Each point on curve represents the arithmetic mean of 28 analyses.)

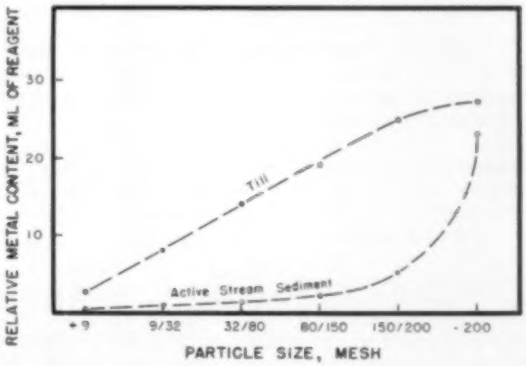

Fig. 7—Heavy metal present as exchangeable ion in till and active stream sediments. (Each point on till curve represents 20 analyses. Each point on stream sediment curve represents 36 analyses.)

rived ions in the coarser fractions and adsorbed in the finer. The total curve slopes reflect a composite of the two origins. The work of Sergeev and the till sample noted earlier support this explanation.

To test the proposed explanation, the stream sediment samples were analyzed by a cold acetate extraction technique. This method extracts the exchangeable ion[11] but does not extract heavy metals present in mechanically derived particles nor those fixed by surface coatings such as iron oxides.[4]

The distribution of exchangeable ion content of the samples is shown in Fig. 7. The metal content of the soil particles increases in the finer fractions, as would be expected, but is very low in the coarser particles.

This decrease of exchangeable heavy metal content in the coarser particles supports the conclusion that the distribution curve for the coarse sizes (Figs. 5 and 6) results largely from particles of mechanical origin. Again it can be said the distribution curve reflects the geologic history of the material sampled.

Some additional support for the above interpretation is provided by tests of active stream sediments from Minnesota's St. Croix State Park area, which is underlain by Keweenawan volcanics. A few of the thinner flows contain native copper. Because of scarcity of outcrops little is known of the detailed spatial relation of sample points to possible zones

of native copper. However, it was believed that if twelve samples were selected from nine separate streams that cut across the strike of the flows, and five samples from the Kettle River, most of the sample points would not overlie or be very close to a copper zone. One sample (No. 7) was collected 200 ft downstream from an exposure of native copper in the Kettle River.

The results of chromograph tests of size fractions are given in Table III.

Table III. Copper Content, Ppm, in Size Fractions of Active Stream Sediments, St. Croix Park Area, Minnesota

Mesh	Average of 12 Stream Samples	Average of 4 River Samples	Sample No. 7 River Sample
−9	8	5	300
−9+32	3	0	50
−32+80	3.5	0	0
−80+150	14	6	10
−150+200	109	56	20
−200	370	240	150

Sample No. 7 and the samples from Fillson Creek (Fig. 5) are similar both in copper distribution and nearness to a mineralized source. The other St. Croix Park samples display a different distribution in that the coarser fractions are very low in copper. This is interpreted as an expression of an additional factor in the geologic history of the material, the effect of transport to a greater distance from the metal source.

Conclusion

Heavy metal distribution data for soil fractions of till and for active stream sediments show that the soil size fraction containing the highest proportion of heavy metals may differ in materials of different geologic history. A channel-flow hypothesis can explain the distribution curve of heavy metals in till. It is suggested that the distribution curve of heavy metals is a result of the geologic history of the sampled material, and it follows that a distribution curve indicates something of the geologic history of the soil.

Understanding of the heavy metal distribution trends is a useful guide in selection of sample material in geochemical reconnaissance work. A great deal more data will be needed before it is possible to make reliable predictions of the type of distribution a certain soil sample might have. It is hoped that this article will stimulate further investigation in materials of various origins.

Acknowledgment

The introductory part of this article and data on distribution in till was presented by the author to the Institute on Lake Superior Geology at Houghton, Mich., May 1956. Permission to include it here is gratefully acknowledged. Funds for the study have been provided by the Graduate School of the University of Minnesota and the Minnesota Institute of Research.

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Graphical Representation of Theoretical Soluble Losses by CCD

by R. J. Woody

DESIGN of the most economic continuous countercurrent decantation (CCD) circuit is based on selection of the number of stages and the wash volume that will give the minimum summation of the following items:

1) Capital and operating costs of the CCD circuit.

2) Capital and operating costs of the precipitation circuit.

3) Value of the dissolved product lost.

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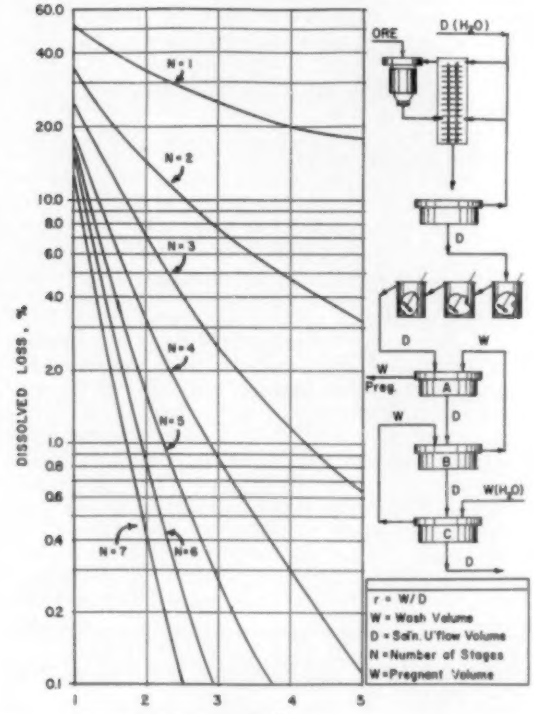

Fig. 1—Straight CCD after water grind.

Items 1 and 2 are fairly straightforward problems of estimating from ore testing data.

Item 3 involves what is commonly referred to as the theoretical soluble loss, and its value is essential in comparing like installations. Once the type of flowsheet is established and the practical operating level of the thickener underflow dilution is determined from the test data, the theoretical loss can be calculated. However, the number of stages and the wash volume must be fixed for each computation, and determination of the optimum layout for CCD and precipitation by this method becomes extremely laborious.

The charts (Figs. 1 and 2) presented here were prepared at the Winchester Laboratory to expedite the study of uranium ores with respect to the possible application of CCD. The flowsheets for which soluble losses are plotted in Figs. 1 and 2 are the two most common for straight CCD washing. A broad practical range of conditions with respect to number of stages and wash ratios is covered in the curves accompanying the flowsheets.

The soluble loss is expressed as a percentage of the desired product that is in solution in the feed to the CCD circuit.

The symbols D and W of Fig. 1 are liquid volumes in thickener underflow and overflow respectively and are assumed to remain constant at all stages. These quantities are commonly expressed as volume tons (32 cu ft) per ton of ore treated. D is determined by laboratory or pilot plant testing and represents the volume of solution per unit of dry solids in the pulp at or near its terminal density. In the determination of washing efficiency, the ratio of W to D is the controlling factor, rather than the size of either quantity, and values of W/D (r) constitute the horizontal axes of the charts.

Derivation of Soluble Loss Formulas

Water Grind Flowsheet (Fig. 1)

Let x = valuable product that was dissolved in the agitator circuit and lost in the last CCD thickener underflow in pounds per ton of ore.

And, let $W/D = r$
C underflow, $C_u = x$
C overflow, $C_o = rx$
From product balance at thickener C:
$B_u = C_u + C_o - \text{zero} = x(r + 1)$, and
$B_o = r\,B_u = x(r^2 + r)$.
From product balance at thickener B:
$A_u = B_u + B_o - C_o = x(r^2 + r + 1)$, and
$A_o = r\,A_u = x(r^3 + r^2 + r)$.
From the overall product balance:
Total dissolved in CCD feed $= C_u + A_o$
Percentage loss for three stages is,

$$\frac{100\,C_u}{A_o + C_u} = \frac{100\,x}{x(r^3 + r^2 + r + 1)}$$

The general formula for N stages is, therefore:

$$\text{Soluble loss, pct} = \frac{100}{r^N + r^{N-1} + r^{N-2} + \ldots .\, r^{N-N}}$$

The following example illustrates a method of using the chart in Fig. 1:

Problem: Find the combinations of number of stages (N) and pregnant solution volumes ($W = rD$) that will yield a theoretical soluble loss of 0.2 pct if the thickener spigot dilution is 0.8 volume tons per ton of ore. The essential numbers may be quickly found and tabulated (Table I).

Table I. Combinations for 0.2 Pct Soluble Loss (D — 0.8)

Stages	7	6	5	4
r	2.3	2.6	3.2	4.4
Preg (rD)	1.8	2.1	2.6	3.5

It is readily apparent that information of this type is useful in estimating the combined costs of CCD and precipitation. If cost plus soluble losses is compared at enough loss levels the optimum layout with respect to number of stages and size of precipitation circuit can be established. The optimum theoretical soluble loss can also be determined.

The curves in Fig. 2 differ from those in Fig. 1 because the flowsheets are different. In the flowsheet represented by Fig. 1 water enters the feed end of the mill in volume equivalent to D, and wash volume (W) is applied at the last stage of thickening. In the flowsheet for Fig. 2 wash volume W, applied to the last thickener, is the only water added, and the water required in the grinding circuit is taken from the second stage of CCD. This solution re-enters the CCD circuit at stage 1 via the leached pulp. This type of flowsheet is very common in cyanidation. Fig. 2 also applies to acid leaching and CCD following a dry grind.

Although r in Fig. 2 is also W/D, the volume of pregnant solution per ton of ore is W minus D. Total water required in Fig. 2 is W, whereas in Fig. 1 it is W plus D. Evaporation losses are of course neglected in the estimation of theoretical soluble losses.

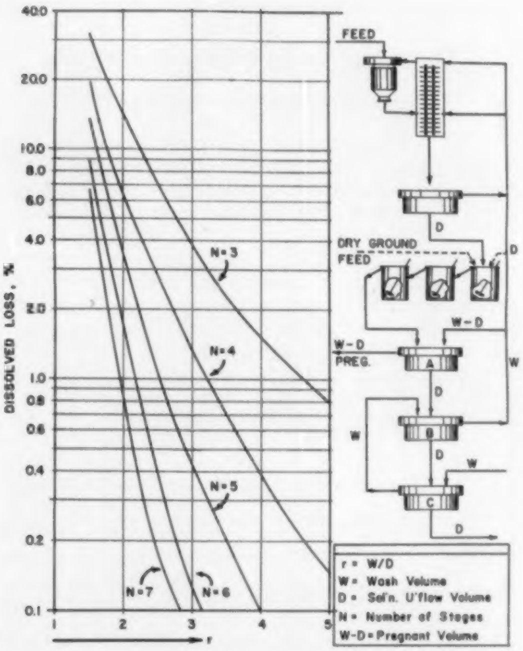

Fig. 2—Straight CCD after grinding dry or in solution.

The curves in each of these charts are the result of substitution in formulas developed for the particular flowsheets. The derivation of these formulas is presented here.

Figs. 1 and 2, and perhaps other charts like them, could be extremely useful to the design engineer for determining the most efficient system to recover products dissolved from ores and similar raw materials. Such charts are also useful for comparison of actual and theoretical washing efficiency of existing plants.

Derivation of Soluble Loss Formulas

Solution on Dry Grind Flowsheet (Fig. 2)

According to the same nomenclature used in the derivation for Fig. 1:

$C_u = x$, and
$C_o = r\,x$.

From product balance at thickener C:
$B_u = C_u + C_o - \text{zero} = x(r+1)$, and
$B_o = r\,B_u = x(r^2 + r)$.

From product balance at thickener B:
$A_u = B_u + B_o - C_o = x(r^2 + r + 1)$, and

$$A_o = \frac{W-D}{D} A_u = (r-1)\,A_u$$
$$= x(r^3 - 1).$$

From the overall balance:

$$\text{Total dissolved} = C_u + A_o$$
$$= x + (xr^3 - x)$$
$$= x\,r^3$$

Percentage loss for three stages:

$$\text{Soluble loss, pct,} = \frac{100x}{xr^3}$$

For N stages:

$$\text{Soluble loss, pct} = \frac{100}{r^N} = 100\left(\frac{D}{W}\right)^N$$

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Distribution Curves for Sink-and-Float Separation of Iron Ores

by Rudolph G. Wuerker

WITH the growing complexity of ore dressing processes and the diversity of equipment, efficiency control has become increasingly important in beneficiation. In the case of iron ore dressing, there have been sporadic attempts[1-3] to establish the optimum separation for various ores so that grade and recovery would be readily predictable. But no rigorous statistical analysis and graphical presentation of such tests could be found in the literature of this country.

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Tests Made with Iron Ores

Expanding upon existing methods of plant supervision and efficiency control, an investigation was started in the ore dressing laboratory at the University of Illinois on the applicability of distribution analysis to iron ores. A sample of crude ore was obtained from the Ohio mine of Cleveland-Cliffs Iron Co. at Ishpeming, Mich., consisting mostly of alternating bands of hematite and siliceous gangue, both about ¼ in. wide. The ore was heavily coated with limonite, which often filled the cracks.

For the sink-and-float tests the ore was screened to the following sizes (inches): −1.05 +0.742; −0.742 +0.525; −0.525 +0.371, and −0.371 +0.185. The screened ore was then pre-soaked and subjected to heavy liquid sorting. The highest specific gravity, 3.59, obtained in the tests was reached in an aqueous solution of thallous formate and thallous malonate. At 3.29 sp gr, methylene iodide was employed. This was easily diluted with benzene to obtain lower densities.

At 2.96 sp gr the investigators used acetylene tetrabromide, which could be diluted with carbon tetrachloride to lower the specific gravity to about 2.73. Tests were stopped here, as this value is about the density of quartz or gangue.

The various fractions were set aside and the heavy liquids washed off; the ore was air-dried, crushed, and sampled for chemical analysis. Following the procedure outlined in a U. S. Steel publication,[4] assay was made for iron and for insoluble material, assuming that the latter was representative of quartz in the ore. Determination was made only for iron and insoluble, as these constituents influence the price of ore most, but any other constituent such as phosphorus and sulfur might be the object of a distribution analysis.

Calculations: The laboratory data in columns 1, 2, and 4 of Table I are followed by the calculations made in constructing distribution curves. Column 3 gives the percent weight of sink based on the total weight. Column 4 is the percentage of iron for each layer of separation as determined by separate analysis. Column 5 is the weighted product of percent weight of sink times its respective percent of iron, often referred to as *iron units*. Its dimension is percent times percent, equal to 1/10,000; however, it is customary to express the products in whole numbers. Column 6 is the cumulative percent weight of sink for each specific gravity separation, that is, the total percent that would sink at each specific gravity range. It is found by adding percent weights from column 3. Column 7 is cumulative percent iron in percent weight found by adding percents in column 5. Column 8, the cumulative percent iron in sink, is found by dividing column 7 by column 6. Column 9 is the cumulative percent weight of float for each specific gravity range. It is determined by assuming that 100 pct of the sample will float at the highest specific gravity and then subtracting the total or cumulative percent weight of sink for succeeding specific gravity ranges from 100 pct. Column 10, the cumulative percent product of the float, is derived by making additions in column 5, working from the bottom up. Column 11, the cumulative percent iron in the float, is calculated by dividing column 10 by column 9. Column 12 is the Fe-Distribution Ordinate for the sample. Each number in this column is obtained by adding half the corresponding number in column 3 to the sum of the preceding numbers in column 3.

Similar steps are necessary to prepare data showing distribution of the insoluble or any other constituent in the various gravity layers.

Plots of Distribution Curves: Plots of measured and computed data in the form of distribution curves provide a means of quick interpretation. The shape of a curve tells at a glance whether a feed is easy to clean, or whether it cannot be improved by cleaning processes, such as used in the present investigation.

Of all the plots possible, only the four most important will be discussed here. They are shown in Figs. 1 and 2 and in the most general terms are designated as:

1) Fe-distribution curve (D)
2) Cumulative concentrated (sink) (A)
3) Cumulative tailings (float) (R)
4) Specific gravity curve (Sp.Gr.)

Curve D is plotted using the midpoint of each successive layer as an ordinate and the corresponding content of the constituent the investigator is most interested in as abscissa. In the present case this is Fe. Curve D is the plot of the values in column 12 vs column 4 of Table I. Curve A is the plot of column 6 vs 8; curve R the plot of column 9 vs 11. The specific gravity curve uses weight percentages as ordinates and specific gravities as abscissas (column 1 vs 6). It gives the specific gravity required to effect any desired separation.

Interpretation of Distribution Curves: Idealized distribution curves for sink-and-float tests are given in Fig. 3a. The general arrangement is similar to the well known washability curves used in coal preparation (or in more general terms, in a float-and-sink process) except that the coordinate system has been turned through 180° and, of course, *sink* and *float* have been interchanged on the ordinates. This graphical representation suggests itself because it is based on the principle of reversibility of the two cases of distribution analysis in gravity separation. In Fig. 3a an imaginary iron ore, easily cleaned, and another one that is difficult to clean are condensed into one diagram. Here a sharp break of the Fe-distribution curve D shows the ease of cleaning, while a diagonal trend indicates the presence of a considerable middling problem, as D approaches the dotted line R in position and direction.

It is evident that the iron ore tested follows this pattern from the plot of experimental data in Table I (size +0.742 −1.05). Fig. 1 shows the Fe-distribution ordinate of this size and also its cumulative concentrate (sink) and cumulative tailings (float) curves. Theoretical recovery at various densities can be graphed from them. An attempt to separate the +0.742 −1.05 size (Table I and Fig. 1) at 2.8 sp gr would obtain, theoretically, 73 wt pct of concentrates with an iron content of 50.2 pct and 27 wt pct of tailings with 11.5 pct Fe. The Fe-distribution curve has a diagonal trend, indicating a definite middling problem. However, in the case of the +0.371 −0.525 size (Fig. 2) the ore had been crushed to a higher degree of liberation and a higher ratio of concentration was attained. A second attempt to separate at 2.8 sp gr would obtain, theoretically, 85.5 wt pct of concentrates with an iron content of 53.5 pct and 14.5 wt pct tailings with 19 pct Fe. It can be seen from Fig. 2 that 2.8 sp gr is not the optimum point and that higher ratios of concentration could be obtained with lower densities.

Besides the foregoing interpretations, the distribution curves with the necessary data can show:

1) Amount and distribution of impurities (silica and sulfur in the case of iron ore) in the different specific gravity fractions.

2) The degree to which a feed can be improved by gravity methods, with amount and kind of products to be expected.

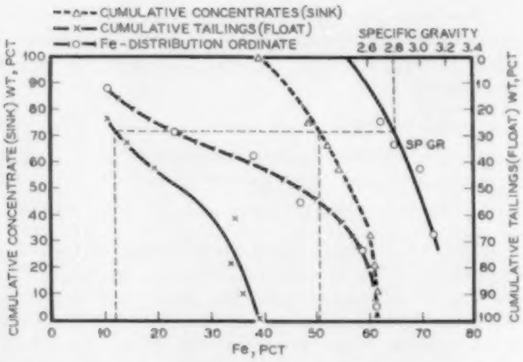

Fig. 1—Distribution curves (series 1) of Ohio mine ore, size +0.742—1.05.

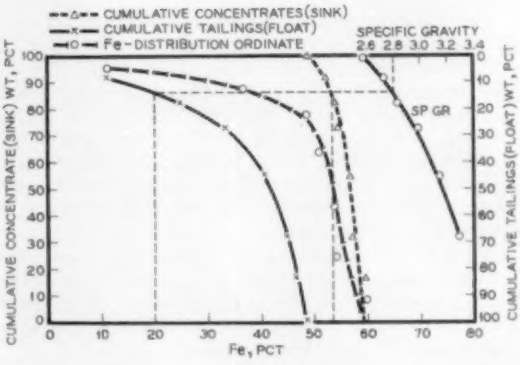

Fig. 2—Distribution curves (series 3) of Ohio mine ore, size +0.371—0.525.

3) A suggestion as to the best type of cleaning plant for the mineral under investigation.

4) An indication as to whether the feed will be easy or hard to clean.

5) An indication as to whether a certain high purity product can ever be obtained from a mineral.[6,7] The minimum percentages of deleterious ingredients can be obtained, with recoveries. Inherent impurities can be determined for the purest product of any particular size.

6) Nature and amount of the impurities in any size.

7) Occurrence of impurities as to whether free or locked in the different fractions. This will indicate whether middlings should be recrused and further treated.

8) Efficiency of existing gravity preparation plants.

Relation Between Washability Tests of Coal and Distribution Analysis of Ores

Heavy media preparation is a branch of gravity concentration that was first developed and brought to widespread application in coal preparation.[6,8] The ore dresser, especially the beneficiation engineer on the Iron Range, faced some difficulties in applying this process to his products.

In the *laboratory*, in heavy media separation the particles of lower specific gravity float, and those of higher specific gravity sink, irrespective of particle size or shape. While the preparation of a heavy medium in the case of coal separation (1.2 sp gr) from slate (2.5 sp gr) was relatively easy, the required specific gravity being 1.3 to 1.5, much higher densities were needed to separate, for example, quartz (2.75 sp gr) from iron ore (Fe_2O_3 4.9 sp gr). Heavy solutions or suspensions were needed, having in this case a specific gravity of 2.8 to 3.4. In this high density range solutions can be used economically in laboratory work only. The preparation of suspensions became a prerequisite for economic application of the process in the *plant*. However, the clean separation achieved in the laboratory is unobtainable in this case. At high separating gravities, where viscosity becomes an important factor, particle shape can definitely have a bearing on the position a particle will take. This is particularly true where currents are present. The combination of a current and a flat particle shape may well influence separation. Ferro-silicon (85 pct Fe and 15 pct Si, ground to —48 mesh) seems now to be the most commonly used suspensoid, not only in treatment of iron ores but also in separation of other ores such as zinc, fluorspar, magnesite, and garnet.

In the case of coal the valuable product is in the float, and the sink is discarded, while in most cases of ore dressing the values (concentrates) are in the sink and the float goes to waste. It can be said that in principle the float process is the reverse of the former. According to recent custom, the coal preparation engineer calls his process *float-and-sink* and the ore dresser speaks of his methods as *sink-and-float*, each one indicating that the object of his preparation process is in the first named word.

Following this assumption, all methods and techniques used in connection with heavy media preparation of coal should be applicable to sink-and-float processes for ores. Furthermore, the float-and-sink process is not restricted to coal preparation. It is

Table I. Observed and Computed Data for Distribution Curves of Ohio Mine Iron Ore, Size +0.742—1.05.

1	2	3	4	5	6	7	8	9	10	11	12
					(Sink) Cumulative Concentrates			(Float) Cumulative Tailings			
Sp Gr	Sink Wt, Grams	Sink Wt, Pct	Iron, Pct, Assay of Fraction	Fe-Units in Fraction Col. 3x4 (x10⁻⁴)	Wt, Pct	Products (x10⁻⁴)	Iron, Pct Col. 7:6	Wt, Pct	Products (x10⁻⁴)	Iron, Pct Col. 10:9	Fe-Distribution Ordinate, Pct
3.51	167.7	10.9	61.20	668	10.9	668	61.2	100.0	3940	39.5	8.5
3.29	149.0	9.7	60.31	586	20.6	1254	60.9	89.1	3281	36.9	15.7
3.14	178.0	11.6	58.77	681	32.2	1935	60.2	79.4	2695	33.9	26.4
2.95	390.0	25.4	46.96	1192	57.6	3127	54.3	67.8	2014	29.6	44.9
2.83	142.0	9.3	38.26	356	66.9	3483	52.2	42.4	822	19.4	62.2
2.73	137.0	8.9	23.27	207	75.8	3690	48.7	33.1	466	14.2	71.3
<2.73	371.0	24.2	10.70	250	100.0	3940	39.49	24.2	250	10.7	87.9
Totals	1534.7	100.0									

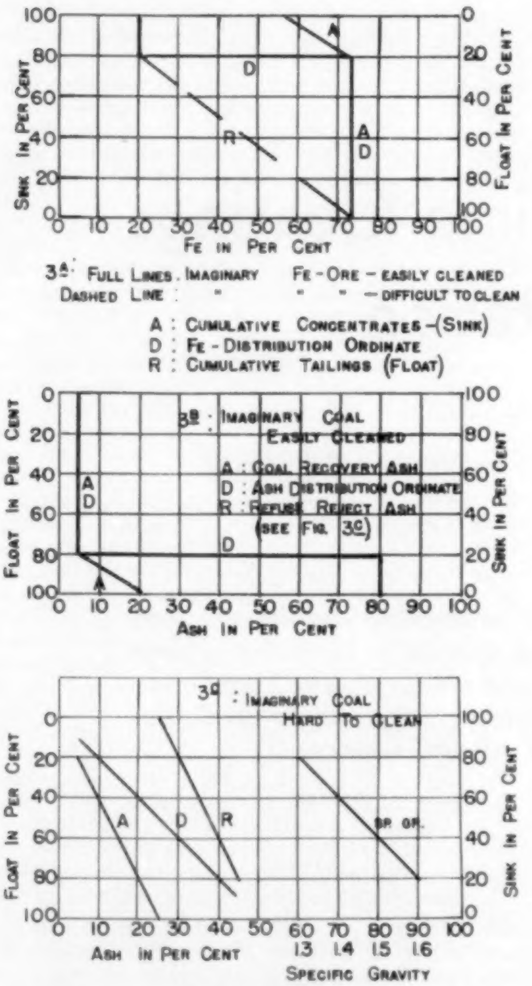

Fig. 3a (above)—Idealized distribution curves of iron ore. Fig. 3b (center)—Idealized distribution curves of coal, easily cleaned. Fig. 3c (below)—Idealized distribution curves of coal, hard to clean.

merely the best known example of a separation where the float is recovered. Likewise, the use of iron ore as a prototype for a sink-and-float process does not limit the application to this one type of ore. It is merely the most important one in terms of tonnage and it is the ore used in the present investigation.

This reversibility, together with the terms most commonly used by the ore dresser and coal preparation engineer, respectively, is presented in Figs. 3a-3c. If a distribution analysis is made of various sizes of a feed, the curve with the sharpest break shows the size at which the highest degree of liberation will be obtained. The method used here to plot the curves of an iron ore distribution analysis seems the logical way of indicating that they are the reverse of the washability curves of coal and that both result from the statistical process of distribution analysis.

Further Evaluations of Results of Distribution Analysis

Having pointed out the applicability of heavy media testing to float-and-sink as well as to sink-and-float types of feed, it is reasonable to assume that other common interpretations of coal washability curves, such as the ±0.10-sp gr curve and the Tromp curve, could be used with benefit by the ore dresser.

Since distribution analysis is universally valid, physical properties other than specific gravity can be used to check both the amenability of ores to preparation processes and the efficiency of plant performance. These are: 1) differences in magnetic force, 2) differences in electric fields, and 3) differences in properties related to froth flotation.

In the case of magnetic separation, an actual investigation is on record.[8,9] Low grade iron ores were tested in heavy media as well as with magnetic separation, and distribution curves were plotted. However, a coordinate system different from the one in the present article was used. C. C. Dell[10] used properties related to froth flotation for distribution analysis.* H. Heidenreich's book[11] lists numerous possibilities of expanding the three basic distribution curves.

* In the discussion following presentation of Dell's paper it was observed that this was merely a modification of the float-and-sink test used in coal washing.

Summary

A method has been developed for establishing a standard to determine the theoretical optimum of a beneficiation process for plant supervision and efficiency control. It has been proved that the distribution curves in heavy media testing of iron ores (sink-and-float) are merely the reverse of the washability curves in heavy media testing of coal (float-and-sink) and that both result from the statistical process of distribution analysis. Implications of this principle of reversibility are discussed, and possible applications to other processes of ore dressing are suggested.

Acknowledgments

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Discussion of this article sent (2 copies) to AIME before Aug. 31, 1958, will be published in MINING ENGINEERING.

Iron Oxide Slime Coatings in Flotation

by D .W. Fuerstenau, A. M. Gaudin, and H. L. Miaw

A quantitative method for evaluating density of slime coatings has been developed and applied to formation of iron oxide slime coatings on quartz and on corundum. Slime coating density is related to flotation recovery and to properties of the electrical double layer at mineral surfaces.

IN spite of considerable study,[1-5] the nature of slime coatings in flotation is still not completely understood. However, phenomena that control flocculation and dispersion of colloidal systems are now interpreted in terms of electrical double layers.[6,7] Colloids will flocculate even though the particles carry the same charge, but when two dispersed colloids of opposite charge are mixed, flocculation ensues even more rapidly. Analogous phenomena seem responsible for slime coating on minerals in flotation systems.

To shed new light on the issue it was considered desirable to devise a tool that would measure slime coatings. The usual method has been to examine photographs of presumably representative surfaces, after an intervening washing in running water. But such an examination is non-quantitative, and the changes in chemical environment represented by the washing may have removed the slime coatings that existed during flotation. To provide the possibility for a correlation with electrical double layer phenomena, the experiments were made with quartz, corundum, and iron oxide, for which electrokinetic data are available.[8-10] Since the properties of the electrical double layers of these oxides depend on the pH of the solution, pH will be the most important variable. Furthermore, because the zero point of charge for silica, iron oxide, and alumina occurs at pH 3.7, 8, and 9.5, respectively, the relative charge on the slime and mineral can be changed over wide ranges. Because of its practical importance in quartz flotation, iron oxide powder was chosen as the slime. Also, its uniform composition, contrasting color, and ease of analysis make experimentation simple.

In this investigation, correlation was sought between the effect on flotation recovery of slime addition and slime coating density.

Materials and Methods

Details are available in a thesis by Miaw.[11] The quartz was selected from pure Brazilian crystalline quartz, crushed, sized (65/150 mesh) acid-cleaned, washed, and stored in conductivity water. The corundum (synthetic alumina of high purity prepared by Linde Co., Chicago) was crushed, sized (65/100 mesh) deslimed, boiled in nitric acid, washed, and stored in conductivity water. The iron oxide slime, reagent-grade ferric oxide (−400 mesh) from Allied Chemical & Dye Corp., was heated to 160°C, cooled, and stored in a vacuum desiccator. In the electron microscope the slime particles appeared to be about 0.3μ in size, but their large specific surface (87,900 cm^2 per g, by gas-adsorption method, using krypton) suggests that the actual particles are smaller than 0.3μ. Had they been perfect nonporous spheres, they would have had a diameter of 0.13μ.

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TP 4767B. Manuscript, Jan. 6, 1958. New York Meeting, February 1958.

The flotation tests were made in a modified Hallimond micro-float cell[9,10] in which nitrogen gas was introduced at the rate of 0.3 ml per sec for 1 min following a 10-min conditioning period without gas. Sized mineral, very coarse compared to slime yet fine enough to offer no obstacle to flotation, was mixed in aqueous suspension with iron oxide slime, then floated at the predetermined and controlled rate. The dried float was weighed and the recovery was calculated. Quartz flotation tests were made with 1 g of 65/150-mesh quartz in 100 ml of water containing 25 mg per liter of purified dodecylammonium acetate. Corundum flotation tests were made with 1.4 g of 65/100-mesh corundum in 100 ml of water containing 12.5 mg per liter of purified sodium dodecyl sulfate. Adjustment of pH was made with HCl or NaOH.

Quantitative slime-coating studies were made by conditioning 2 g of mineral in 100 ml of solution with slime, with or without flotation reagents as desired.

Preliminary experiments were made to find out whether the time of agitation of the mineral with the slimy liquor had any effect. It was found that the slime coating increased with time up to 10 min, thereafter remaining substantially independent of time.[11] Accordingly, a 10-min agitation period was adopted for the rest of this work, even though it was realized that the time required for slime-coating formation may vary with the prevailing chemical conditions and with the system under study. After conditioning, a mineral charge was elutriated with a liquor having the composition of the flotation liquor prior to the addition thereto of mineral and slime. The ascending rate in the elutriator was adjusted to retain the mineral with adherent slime and overflow the non-adherent slime. The mineral was then leached with acid to dissolve the slime, and the iron was determined spectrophotometrically.[14] The light absorbance of the solution was measured in a Beckman Model DU spectrophotometer.

Flotation Results

Quartz-Slime System: A small amount of iron oxide slime in the system has a marked effect on flotation of quartz in that recovery is 85, 50, 6, and 2 pct in the presence of 0, 10, 20, and 40 mg slime per liter of water, respectively. Consequently pH-recovery curves were made at different slime concentrations. In the absence of iron oxide slime the recovery-pH curve is as shown in Fig. 1, curve *A*. The recovery is not affected by pH changes from 5.5 to 12. Below pH 5.5 the recovery decreases, first gradually, then rapidly, from 85 pct at pH 5.5 to 13 pct at pH 2.6.

In the presence of 25 mg per liter of ferric oxide slime, recovery begins to drop at pH 9 and becomes zero at pH 6 (Fig. 1, curve *B*). Increasing the slime content shifts the recovery curve increasingly toward the right. With 1 g per liter of slime (curve *D*) the floatability is greatly inhibited below pH 10.5.*

Corundum-Slime System: A similar study was made with corundum instead of quartz and sodium dodecyl sulfate in place of dodecylammonium acetate. The results shown in Fig. 2 suggest a mirror-image relationship for quartz and corundum.

Amount of Ferric Oxide Slime Coating

Quartz-Slime System: Using the slime elutriation technique, two series of tests were made on quartz without collector, one with a slime concentration of 1 g per liter and the other 2 g per liter. The results, presented in Fig. 3, show that maximum coatings of 10 mg and 12 mg of slime per gram of quartz, respectively, occur at about pH 8.

Three sets of tests with collector were made, each with pH as the independent variable. In sets *A* and *B*, the mineral was conditioned with slime and collector simultaneously for 10 min (*A*: 1 g per liter of slime, 25 mg per liter of dodecylammonium acetate; *B*: 1 g per liter of slime, 50 mg per liter of collector). In set *C* the mineral was conditioned first for 5 min with collector (25 mg per liter) and then slime was added for a second 5-min conditioning to give a slime concentration of 1 g per liter. Thus the total additions in sets *C* and *A* were the same, but the sequence was different. Results obtained are shown in Fig. 4, *A*, *B*, and *C*, respectively.

Comparison of the slime coating with and without collector shows that the collector in general reduces the slime coating except within a sharply delineated pH band between pH 9 and 10.

Corundum-Slime System: Fig. 5, curve *A*, shows results obtained with 1 g per liter of slime and no collector, at various pH values. Maximum coating, which is much less than that found for quartz, occurred at pH 8, and the coating decreased similarly on both sides of the peak.

Two sets of tests were made with collector, one with 12.5 mg per liter of sodium dodecyl sulfate, the other with 30 mg per liter. Results obtained are shown in Fig. 5, curves *B* and *C*, respectively. The peak of curve *B* (2.6 mg per g corundum) occurred at about pH 7, and the peak of curve *C* (5 mg per g corundum) at about pH 8. Thus, increasing collector concentration increases the coating.

Slime Coating Density

On the assumption of perfect cubes or spheres of average size, the calculated surface of the quartz used is 153 cm^2 per g. The measured surface (BET method, krypton) was 271 cm^2 per g, indicating a surface factor of 1.77. This is in line with the measurements of Hukki[15,16] and Yavasca[17,18] for a comminuted material in a size range displaying only a very small proportion of internal surface. It will be assumed that the *external* surface of the quartz used was 250 cm^2 per g.

The calculated surface of the alumina, on the assumption of perfect cubes or spheres of average size, is 86 cm^2 per g and the measured surface 276 cm^2 per g. In view of the sintered nature of the product and the small specific surface, it is believed that most of the measured surface is external surface, the large surface factor (3.2) being accounted for by the elongated habit of the particles. It will be assumed that in this case the specific external surface was 200 cm^2 per g.

The slime had a specific surface (BET, krypton) of 87,900 cm^2 per g corresponding to spheres 0.13 μ in diam. The appearance of the slime particles under low-power electron microscopy suggested an average size not over 0.3 μ. It will be assumed that the slime was of such a size that a complete con-

* For comparison, quartz was floated with dodecylammonium acetate in the presence of alumina, calcium fluoride, and kaolinite slimes. The adverse effect of alumina slime is similar to that of ferric oxide slime, whereas that of the two other slimes is different. Neither calcium fluoride nor clay inhibit the floatability above pH 7; however, in acid circuits clay slime seems to be less effective as a depressant than calcium fluoride slime.

tinuous monolayer would have been 0.2 μ thick, or weighed 0.10 mg per cm^2.

When these evaluations of mineral surface and slime-particle size are applied to the data of Figs. 3, 4, and 5 the following consequences emerge:

1) Maximal coating obtained on quartz, without collector, was 40 pct and 50 pct complete for the two slime additions tested.

2) Maximal coating on quartz, with collector, was about 45 pct (Fig. 4).

3) Maximal coating on corundum, without collector, was 7 pct (Fig. 5, *A*).

4) Maximal coating on corundum, with collector, was 25 pct (Fig. 5, *C*).

It is interesting to observe that the slime coating colored the mineral faintly in some cases, distinctly in most. In the case of corundum, without collector, just the coloring due to slime was noticeable across the central pH range. In all the other systems the coloring was much more intense.

Correlation between Slime Coating Density and Flotation Recovery

Since flotation follows the formation of partly complete collector monolayers 20A in thickness, and since slime coatings have now been shown to be partly complete monolayers about 2000A in thickness, it is interesting to examine their interplay.

First, it is possible that the slime consumes the collector. In the quartz-iron oxide slime-dodecylammonium acetate system, the data of Morrow[19] suggest that the collector consumed by the slime is but a very small percentage (3 pct) of the collector added.[11] For the corundum-iron oxide slime-sodium dodecyl sulfate no such estimation can be made, as adsorption data are lacking.

In the quartz system, therefore, the effect of slime coating on flotation, which is so great (Fig. 1), must be sought not along chemical lines but rather along mechanical or hydrodynamic lines. The authors are inclined to the view that a slime-studded mineral surface has a much smaller probability of making fertile contact with an air bubble than a clean surface.

Fig. 6 brings together data from floatability and from slime-coating density for the quartz system. *A* is the pH recovery curve in the absence of slime, *B* the pH recovery curve with slime present, and *C* the slime-coating density vs pH curve. The relationship between slime coating and decreased recovery is plainly seen.

Role of the Electrical Double Layer on Slime Coatings

The nature of the electrical double layers that surround both the slime particles and the coarser mineral particles has several effects on slime coating phenomena.

In this investigation the maximum slime-coating density was found to be about 50 pct coverage. Possibly this constitutes complete coverage, because the interaction of the double layers about two slime particles will prevent these particles from contacting each other. Under the conditions used in the authors' experiments, the electrical double layers are about 0.1 μ thick; hence the effective diameter of a slime particle will be 0.5 μ and not 0.3 μ.

The potential in the Stern plane, the zeta potential, is important in flocculation and dispersion, but since this potential varies with distance between particles whose double layers are interacting,[17] measurement of ζ will not yield the correct answers under flocculating conditions. Thus electrokinetic experiments in slime coating studies are valuable mostly for finding the identity of the potential-determining ions and for locating the zero point of charge, although the experiments may *indicate* the magnitude of the potential in the Stern plane under flocculating conditions. The charge at the surface of the three oxide minerals used in this investigation is controlled by the pH of the solution. Silica, iron oxide, and alumina are negatively charged at pH values greater than 3.7, 8, and 9.5, respectively, and are positively charged at pH values lower than these values.[9,11,12] The slime coating would be expected to be heaviest under conditions in which the slime is uncharged or is charged oppositely to mineral. Thus the densest coating of iron oxide slime on quartz should occur in solutions near neutral pH and the coating density should decrease as the pH becomes acid or basic. This is just what occurs (Fig. 3). Also, the densest iron oxide slime coating on corundum should occur at pH values where the minerals are oppositely charged, that is, between 8 and 9, but since the isoelectric points of iron oxide and alumina differ by only 1.5 pH units, the coating should be less than that on silica. This again fits the facts.

Summary

A new method has been developed to study quantitatively the slime coatings formed in flotation. It has been applied to a few simple systems. Correlation between coating density and decreased recovery is shown. Correlation between coating formation and surface charge is an inviting subject for further study.

Acknowledgment

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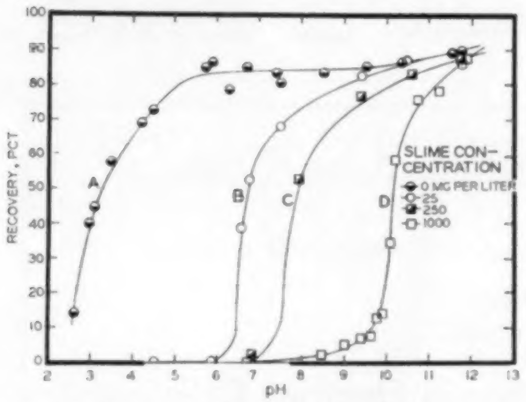

Fig. 1—Effect of ferric oxide slime on flotation of quartz as a function of pH. Test conditions: quartz, 1.0 g; water, 100 ml; DAA, 25 mg per liter; conditioning time, 10 min; flotation time, 1 min; gas flow, 0.3 ml per sec.

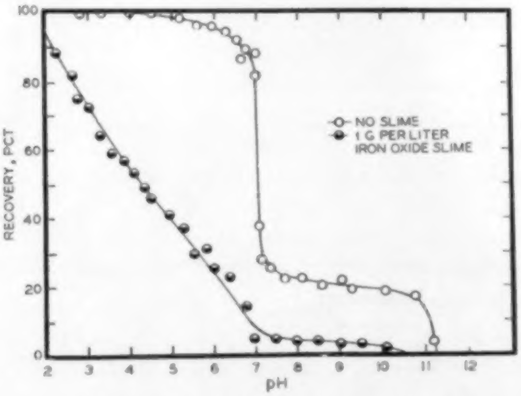

Fig. 2—Effect of ferric oxide slime on flotation of corundum as a function of pH. Test conditions: corundum, 1.4 g; water, 100 ml; SDS, 12.5 mg per liter; conditioning time, 10 min; flotation time, 1 min; gas flow, 0.3 ml per sec.

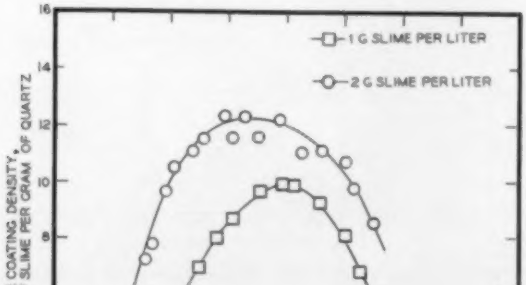

Fig. 3—Effect of slime concentration and pH on the ferric oxide slime coating density on quartz in the absence of collector.

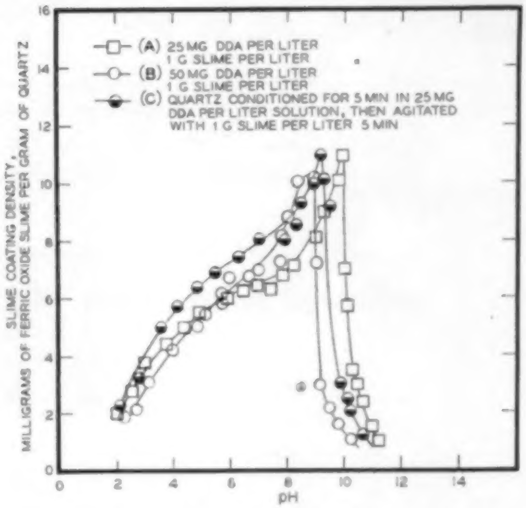

Fig. 4—Effect of conditioning and collector concentration of ferric oxide slime coating density on quartz.

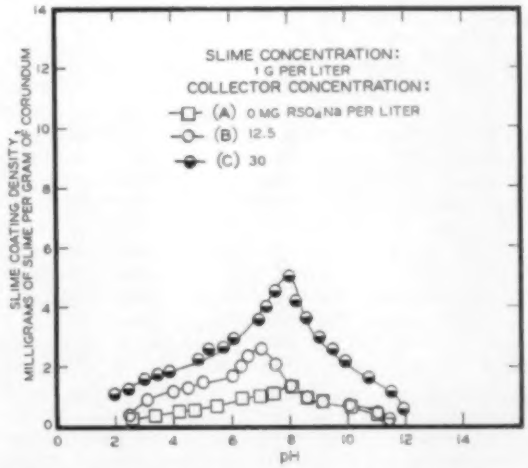

Fig. 5—Effect of collector addition on ferric oxide slime coating density on corundum.

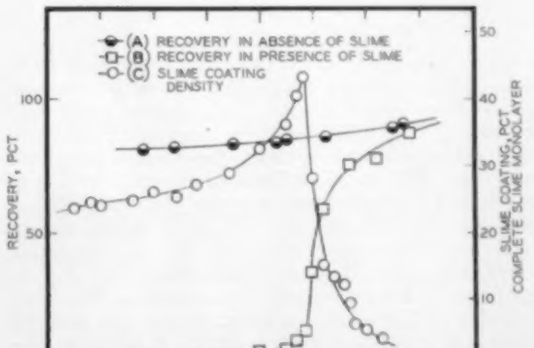

Fig. 6—Relationship of recovery to slime coating density for quartz and 1 g per liter of iron oxide slime with 25 mg per liter dodecylammonium acetate as collector.

Technical Note

Improved Method for Measuring Aeration in Flotation Cells

by John B. Gayle

PRESENT flotation processes depend almost entirely on the buoyant properties of air bubbles to effect separations of mineral and gangue, but there is no convenient method for measuring aeration in flotation cells. Consequently the relation between aeration and cell performance has not been definitely established.

In connection with a comparative study of kerosene and froth flotation processes, a modification of the displacement method[1] was developed in which air escaping from the cell surface is measured with a wet-test meter. The arrangement shown in Fig. 1 is satisfactory for use with a number of cells and is not critical, except that care must be taken to use connections and tubing large enough to avoid excessive back pressures. Attempts to use smaller tubing resulted in back pressures that caused displacement of the liquid level in the receiver, so that some air was lost around the sides, an occurrence readily visible when measurements were taken with only water passing through the cell. With the arrangement shown, the manometer indicated an average reading of about ½-in. water pressure. No loss of air was evident.

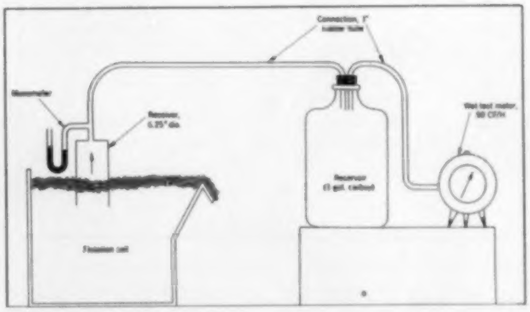

Fig. 1—Apparatus for measuring aeration in flotation cells.

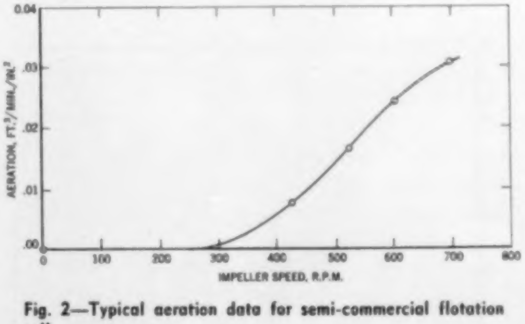

Fig. 2—Typical aeration data for semi-commercial flotation cell.

Fig. 2 presents typical data for a standard Denver sub-A 24x24-in. unit cell operated at impeller speeds from 0 to 710 rpm. Each plotted point represents the average for five readings distributed over the entire cell surface. Readings were taken with only water passing through the cell. Results of this type have been used in a study of the influence of operating variables on cell performance and in detecting inherent differences in the operating characteristics of cells of various kinds.

Although the information presented in Fig. 2 resulted only with water passing through the cell, the apparatus is suitable for use during flotation of coal when various reagents are present. Possible modifications that might prove convenient under special circumstances include varying the size and shape of the receiver and substituting a calibrated, inverted, water-filled carboy or other gas-measuring device for the wet-test meter. If such modifications result in excessive back pressures, some form of draft should be applied at the discharge end of the measuring system.

J. B. GAYLE is Chief, Coal Laboratory, Southern Experiment Station, Tuscaloosa, Ala., Region V, U. S. Bureau of Mines.

TN 460B. Manuscript, April 28, 1958.

Reference

1 Denver Equipment Co.: *Handbook*, 1954, p. 610.

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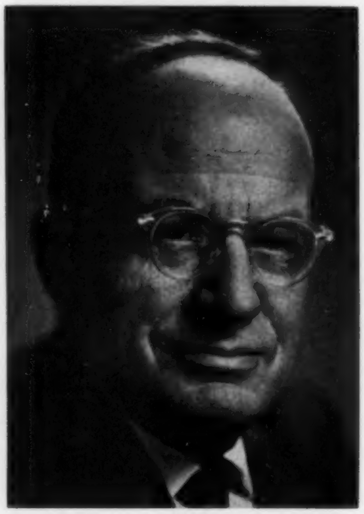
Nominations Are Announced for 1959 AIME Officers

Three Society Nominating Committees Present Slate for 1959 Institute Officers and Directors



J. L. GILLSON

President-Elect

Joseph L. Gillson has been nominated for AIME President-Elect by the Society of Mining Engineers to take office as President in 1960. Mr. Gillson, who is chief geologist for the E. I. du Pont de Nemours & Co., is currently serving his second term as Vice President of AIME, is Vice Chairman of the Executive Committee, and is Chairman of the Member-Gifts Campaign Program for AIME members for the new United Engineering Center. He will become president of the Soc. of Economic Geologists in April 1959, and has been president of the American Geological Inst. A native of Evanston, Ill., Dr. Gillson received his B.A. and M.A. degrees at Northwestern University, and was granted the degree of Sc.D. in geology from Massachusetts Institute of Technology. He taught at Harvard and MIT prior to accepting a position as geologist in 1928 with du Pont. In 1940 he served as a special geological adviser for the government of Travancore, India. He is the author of numerous articles for technical journals and has become a specialist in exploration for titanium ores, in search of sulfur, ilmenite, fluorspar, and other raw materials, as well as investigations of ground water supplies. His travels have taken him over a large part of the world and he is well recognized for his activity in the advancement of the industrial minerals field. In February 1957 he received the AIME D. C. Jackling Award for his significant contribution to the advancement of economic geology, for his leadership, and keen sense of professional responsibility.

Vice Presidents and Directors

Elmer A. Jones has been nominated to serve as AIME Vice President by the Nominating Committee of the Society of Mining Engineers. SME and the Society of Petroleum Engineers are each represented by one incumbent Vice President and will nominate only one candidate this year. Mr. Jones was the first President of SME as established under the reorganization of AIME in 1957. He is manager of Southeast Missouri Div., St. Joseph Lead Co. Born in Minneapolis in 1902, he received a degree in mining engineering from the University of Minnesota School of Mines in 1924. He began his long affiliation with St. Joe in 1926 and has worked in successive positions as mine surveyor, safety inspector, mine engineer, mine superintendent, and assistant general mine superintendent. He is an authority on trackless mining operations.

Thomas C. Frick, recently appointed regional manager of the South Louisiana Region of The Atlantic Refining Co., crude oil production department, has been nominated to serve as AIME Vice President for one year by the Society of Petroleum Engineers. Mr. Frick has been a leader in four AIME Sections as well as SPE, serving as secretary-treasurer of the Mid-Continent Section, branch vice chairman of the Southwest Texas Section, chairman of two other Sections, and chairman of the Petroleum Branch of AIME for 1956. He graduated from the University of Tulsa in 1933 with top honors and joined the Refining Dept. of Phillips Petroleum Co. As assistant professor and head of the Production Dept. of the School of Petroleum Engineering at TU, he was instrumental in founding the AIME Student Chapter there. He gained administrative experience with Atlantic Refining Co. for his sound engineering-executive background and was subsequently district superintendent, regional manager, and in 1956 manager of the Production Div. of the Domestic Crude Oil Production Dept.

E. A. JONES

T. C. FRICK

W. R. HIBBARD, JR.

J. C. KINNEAR, JR.

Walter R. Hibbard, Jr., President of The Metallurgical Society, has been nominated as one of two AIME Vice Presidents by The Metallurgical Society. He is currently manager of alloy studies, General Electric Research Laboratory, as well as an adjunct professor of metallurgical engineering at Rensselaer Polytechnic Institute. He received a degree in physical chemistry from Wesleyan University in 1939 and a doctorate in physical metallurgy from Yale University in 1942. In 1950 he was awarded the AIME Rossiter W. Raymond Award. In addition he has published well over 60 technical papers and served as an officer in the metallurgical section, Bureau of Ships, USN, and has been an assistant professor at Yale.

John C. Kinnear, Jr., first President of The Metallurgical Society, has also been nominated for the Vice Presidency of AIME by the Society. He is general manager, Nevada Mines Div., Kennecott Copper Corp., McGill. He received a B.A. degree from Pomona College, Claremont, Calif., and a B.S. in metallurgy in 1938 at Massachusetts Institute of Technology. Mr. Kinnear has been associated with Kennecott since 1938, and was present at the blowing in of the Hurley smelter, where he became assistant superintendent of the smelter. He has been general manager at McGill since 1950. Active in AIME both on the Local Section and National levels, Mr. Kinnear has served as chairman of the Nevada Section and chairman of EMD.

Directors

Arthur B. Cummins, manager, Central Chemical and Physical Research Dept., Johns-Manville Research Center, has been nominated by the Society of Mining Engineers to serve as AIME Director for three years. Dr. Cummins is an internationally recognized authority in several aspects of mining asbestos, mineralogy, filtration technology of silica, and diatomaceous earth and has written many technical papers, holds 17 patents, and has contributed to process developments, beneficiation, and marketing of the mineral industry. Born in 1895 in California, he graduated from the University of Chicago and was awarded his doctorate by the University of California in 1926, where he was assistant chemist. He joined the Celite Co. (now part of Johns-Manville) in 1924 and advanced rapidly to his present position. He has served on many technical committees and was chairman of IndMD in 1951.

J. W. Woomer, who will be President of SME in 1959, has been nominated by the Society of Mining Engineers for a three-year term on the AIME Board of Directors. A native of Philipsburg, Pa., he received B.S. and E.M. degrees from Pennsylvania State University, working in the coal fields during vacations. He worked for the Pittsburgh Coal Co. and the Hanna Coal Co. before forming his own consulting firm in 1940 which has taken him all over the world for professional work. An active member of the SME Coal Division, Mr. Woomer is presently Division chairman.


A. B. CUMMINS


J. W. WOOMER

John S. Bell has been nominated by the Society of Petroleum Engineers to serve a three-year term as AIME Director. Mr. Bell is California area manager of Humble Oil & Refining Co. Born in Fort Worth, Texas, he attended the University of Oklahoma, receiving his B.S. degree in petroleum engineering in 1930. He joined Humble in 1933 and progressed to division petroleum engineer and in 1955 assumed the area management that he now holds. Active in the AIME since 1939, he has served as chairman of many committees and will be President of the Society of Petroleum Engineers in 1959.

J. S. BELL

The **second AIME Director** representing the Society of Petroleum Engineers will be the 1960 President of the Society. The SPE Nominating Committee will announce his name in the fall and he will become an AIME Director, starting a three-year term in February 1959.

John Chipman has been nominated by The Metallurgical Society to serve as AIME Director for three years. Born in 1897 in Florida, Mr. Chipman received his B.A. degree from the University of the South, and a Ph.D. in physical chemistry in 1926 at the University of California. He has been assistant professor at Georgia School of Technology and a research engineer at the University of Michigan. In 1934 he became associate director of the research laboratories of the American Rolling Mill Co. In 1937 he was professor of metallurgy at Massachusetts Institute of Technology where he became head of the department in 1946. During the war he directed work for production of metals and ceramics for use in nuclear fission experiments, and his many publications and awards testify to the contributions he has made to industry.

Carlton C. Long has been nominated by The Metallurgical Society for a three-year term on the AIME Board of Directors. Mr. Long, director of research, Zinc Smelting Div., St. Joseph Lead Co., is a native of Boulder, Colo. Educated in the west where he received a chemical engineering degree and a Ph.D. in chemistry from Stanford University, he came east in 1935 to join the technical staff of the Josephtown Smelter. A member of AIME since 1937, he has been chairman of the Lead-Zinc Committee in 1948, Metals Branch Chairman in 1951, and a Director of The Metallurgical Society. He has published technical papers dealing with electrothermic zinc and with the development of young engineers.

Incumbent AIME Officers and Directors as of March 1959:

The President of AIME for 1959 will be Howard C. Pyle, *Society of Petroleum Engineers.*

Past-President of AIME in 1959 will be Augustus B. Kinzel, *The Metallurgical Society.*

Vice Presidents in 1959 will be E. C. Babson, *Society of Petroleum Engineers;* and Roger V. Pierce, *Society of Mining Engineers.*

The following will continue to serve as AIME Directors in 1959: L. C. Campbell, F. W. Strandberg, Lamar Weaver, and S. D. Michaelson, *Society of Mining Engineers;* J. P. Hammond and Basil Kantzer, *Society of Petroleum Engineers;* and J. S. Vanick and A. W. Thornton, *The Metallurgical Society.*


J. CHIPMAN


C. C. LONG

Article X of the SME Bylaws provides for representation on the AIME Board of Directors. The parts of *Section 1* provide: **a)** Every third year in rotation with the other two Societies, one member of the Society shall be elected President-Elect of the AIME, who shall serve after the first year and in successive years as President and Past-President of the AIME; **b)** Past-President of the Society (serving for the third year); **c)** President of the Society (serving for the second year); **d)** President-Elect of the Society (serving for the first year); and **e)** Three members at large. Should one of the six individuals listed under **b, c, d,** or **e** be elected President-Elect of the AIME, he will be replaced by appointment by the Executive Council.

Section 2 provides: Each year, two of the Society's representatives on the AIME Board of Directors shall be designated as Vice Presidents of AIME, and shall serve for a term of one year.

The Chairmen of the three Society Nominating Committees have announced nominations for AIME President-Elect, Vice Presidents, and Directors for 1959.

Each of the Society Bylaws provides for additional nominations. (The Bylaws of each Society in substantially final form have been published in the Journals and in revised form in the 1957 Institute Directory.) If no alternate slate is proposed, no letter ballot will be necessary and the selections of the three Nominating Committees will be declared elected in accordance with the respective Society Bylaws well in advance of their installation at the 1959 Annual Meeting in February in San Francisco.

SME Announces Nominations for 1959 Society Officers

A. B. CUMMINS

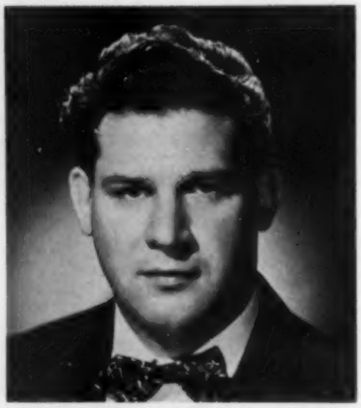
In accordance with the SME By-laws, **Article IX** which provides for the activities of the Nominating Committee and especially Article IX, *Section 11* (see below), the Committee announces the names of those nominated to serve as Society officers in 1959. **Article V,** *Section 1*, provides that members of the Board of Directors shall be chosen to represent the Divisions of the Society, and these nominations for terms beginning in February 1959 are also announced.

Nominated for the office of President-Elect is **Arthur B. Cummins,** manager, Central Chemical and Physical Research Dept. of the Johns-Manville Research Center, Manville, N. J. Born in 1895 in Los Angeles, Dr. Cummins graduated from the University of Chicago in 1920 with a B.S. and earned his doctorate at the University of California in 1920. He joined the Celite Co. (now part of Johns-Manville) and became a development engineer, research engineer, manager of Celite research, manager of basic research, and finally in 1956 manager of the department he now heads. Dr. Cummins has been an active member of AIME, serving on many committees and acting as eastern vice chairman of IndMD, chairman in 1951, and member of the AIME Board of Directors. He is recognized internationally as an authority in mining asbestos, mineralogy, and filtration technology; holds 17 patents; and has written numerous technical papers.

Nominated for the office of Vice President of the Central Regional Area is **Donald W. Scott,** general manager of Continental Sales & Equipment Co. A native of Minnesota, he received an E.M. degree from the University of Minnesota and a master's degree in metallurgical engineering from the University of Alabama. His career started in 1937 at Bingham Canyon, Utah, and he did research work on industrial minerals at the Southern Experiment Station of the U. S. Bureau of Mines at Tuscaloosa, Ala. He spent 12 years at the Battelle Memorial Inst. in Columbus, Ohio, directing research. He is the author of several papers dealing with optical phase identification and methods of beneficiation and in 1951 he organized the company that he now directs, specializing in sales and service of milling equipment. He has served on many AIME committees, acting as chairman of the Ohio Valley Section, first secretary of MBD, and chairman of MBD.

The Coal Division has nominated **James C. Gray** to serve on the SME Board of Directors for a three-year term. Mr. Gray was born in Elco, Pa., in 1904 and graduated from Pennsylvania State University in 1925 with a B.S. in mining engineering. After graduation he worked for Hudson Coal Co. for 12 years and in 1937 became superintendent of the Wylam Mine for U. S. Steel Corp. After holding various management positions in coal and iron mining and manufacturing, he became in 1950 manager of the Tennessee Coal & Iron Div.'s manufacturing operations. Made vice president, coal division of U. S. Steel, Pittsburgh, in 1954, Mr. Gray became, in 1958, administrative vice president, raw materials.

The Industrial Minerals Division nominee for SME Board of Directors is **John G. Broughton,** state geologist, Geological Survey of New York, Albany. Born in 1914 in Rome, N. Y., Dr. Broughton received A.B. and M.S. degrees from the University of Rochester, and a Ph.D. from Johns Hopkins University in 1940. For three years he worked for the U. S. Geological Survey, mapping in gold, base metal, tungsten, and cobalt mining districts in the west. He has been an instructor at Syracuse University and assistant state geologist as well as acting state geologist for New York State. He is the author of publications in structural geology and industrial minerals, has been active on committees dealing with public education in geology, and is serving IndMD as secretary-treasurer.



D. W. SCOTT

The Mineral Beneficiation Division nominee for Director is **William B. Stephenson,** mechanical engineer for the Allen-Sherman-Hoff Pump Co., Wynnewood, Pa. Mr. Stephenson received a B.S. in mechanical engineering from Pennsylvania State University in 1933. He started his career as sales engineer for Cities Service Co., Pittsburgh, and after four years joined Jerguson Gage and Valve Co., Boston. He became associated with his present company in

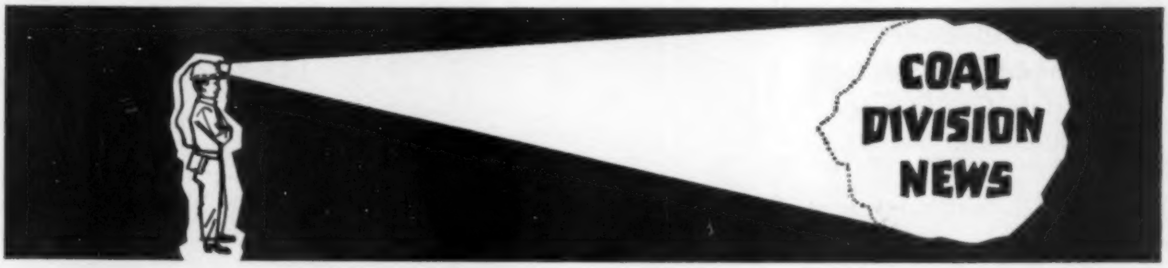
(Continued on page 809)

Section 11 of Article IX, SME Bylaws, provides: "The names and biographies of the nominees shall be published in the July issue of Mining Engineering. Any 25 members of the Society may submit additional nominations to the Board of Directors for one or more of the positions specified . . . [President-Elect and one Regional Vice President].Such nominations shall be submitted not later than September of that year [1958], and notice of the additional nominees for the position or positions designated shall then be published in the October issue of Mining Engineering. . . . If additional nominations are received, a letter ballot for the positions shall be sent on or about November 1 to all voting members of the Society in the United States, Canada, and Mexico. Ballots shall be returned within 45 days after they are mailed.

J. C. GRAY

J. G. BROUGHTON

W. B. STEPHENSON



A great responsibility of industry leadership is to insure the growth of tomorrow's leaders. One of the best ways to foster this growth is by bringing younger men into *their professional society*, and further, to *encourage their activity* in that society and its divisions.

The Coal Division's position as the national professional organization of the industry gives it special value to the younger man as a place where he can become acquainted with the leaders of his profession and his industry. Starting on the local level, continuing on a regional and national basis, the dual channels of meetings and publications provide the younger man one of his greatest opportunities for growth, technical advancement, and executive development.

The Division urges the *older* men to see that their *young* men are encouraged to take this path, and realize some of these opportunities to broaden and better themselves. See that the young men in your organization join the Coal Division—make them welcome—and once in, see that places are provided for their active participation.

Numerous positions on committees and in executive offices offer direct participation for those who make their professional society a vital concern. At a recent meeting of the Coal Division Executive Committee new nominations for responsible positions in 1959 were announced by the Coal Division Nominating Committee.

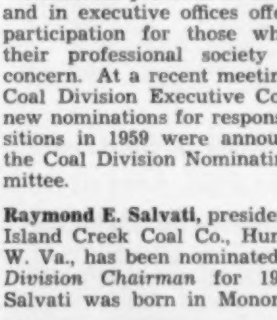
Raymond E. Salvati, president of the Island Creek Coal Co., Huntingdon, W. Va., has been nominated as *Coal Division Chairman* for 1959. Mr. Salvati was born in Monongah, W. Va. in 1899 and received a B.S. at West Virginia University in 1922. He began his career with Island Creek Coal Co. immediately after graduation and was promoted rapidly to superintendent over five mines, then transferred to Pond Creek Pocahontas Co. where he became vice president and director of the company in 1932. He transferred again to Island Creek, maintaining his status with Pond Creek, and advanced from general manager to vice president, director, and finally president of Island Creek in 1949. He is also a director of American Coal Shipping Inc., National Assn. of Manufacturers, National Coal Assn., among other organizations, and is a member of the board of governors of West Virginia University and a past-president. In these positions he has traveled extensively abroad.

H. O. Zimmerman, manager, coal properties, Inland Steel Co., Wheelwright, Ky., is Coal Division *Chairman-Elect*. Mr. Zimmerman was born in South Hadley Falls, Mass., in 1896 and lived in New England until at 18 he went to the coal fields of West Virginia and Kentucky. He started working for Inland Steel Co. in 1930 as chief engineer and then assistant to the manager of coal properties. In 1955, he was appointed manager, the position he now holds. For a period after the war he was connected with the Kentucky State Highway Dept., the Illinois State Highway Dept., and the New York, New Haven and Hartford Railroad. He also attended the advanced management program of the Harvard School of Business. In 1948 he was elected Chairman of the AIME Central Appalachian Section.

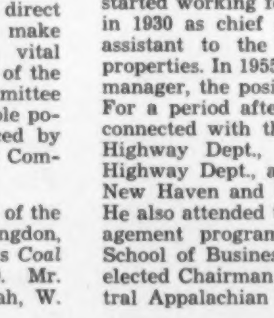
Robert M. Von Storch has been nominated for a three-year term on the *Executive Committee*. Mr. Von Storch is manager of coal mines, Columbia-Geneva Steel Div., U. S. Steel Corp., Dragerton, Utah. Born in Scranton, Pa., in 1908, he studied civil engineering at Pennsylvania State University and started his career with Hudson Coal Co. as mine surveyor. For 23 years he worked there as engineer, sectional foreman, mine foreman, and mine superintendent. In 1953 he joined Columbia-Geneva where he is now general superintendent, coal mines and quarries. He is president of Rocky Mountain Coal Mining Inst.

Henry Charles Rose, president, Consolidation Coal Co., Library, Pa., has been nominated for a three-year term on the *Executive Committee*. Born in Cleveland in 1903, he received a B.E.M. degree from Ohio State University in 1924 and began his affiliation with Pittsburgh Coal Co. in 1928 where he advanced from industrial engineer to superintendent, assistant production manager, production manager, and vice president in 1951. He had also worked for the U. S. Gypsum Co. and the American Rolling Mill Co. He is a member of the Pittsburgh Coal Mining Inst., the Mining Inst. of America, and the National Mine Rescue Assn.

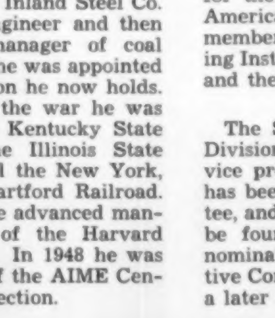
The SME Director from the Coal Division for 1959, James C. Gray, vice president of U. S. Steel Corp., has been nominated by the committee, and a summary of his career can be found on p. 800. One further nomination for the Division Executive Committee will be announced at a later date.



R. E. SALVATI



H. O. ZIMMERMAN



R. M. VON STORCH

Coming Events

Don't forget to attend the AIME-ASME Joint Solid Fuels Conference in October at Old Point Comfort, Va. For meeting details and the technical program, see page 802.

See the August issue for details of Division participation in the Mid-America Minerals Conference.

Next month, the Division will announce plans for the program at the San Francisco Annual Meeting.

Luncheon Speakers Are Announced for October Solid Fuels Conference

The ASME-AIME Joint Solid Fuels Conference will be held October 9 and 10 at the Chamberlin Hotel, Old Point Comfort, Fort Monroe, Va.

The luncheon speaker for the first day will be S. Pemberton Hutchinson, executive vice president of General Coal Co., Philadelphia. Mr. Hutchinson will speak on *The Export Coal Market.*

The second luncheon topic on the following day will be the impact of atomic power development as related to the long term outlook for solid fuels. Theodore Baumeister, Stevens Professor of Mechanical Engineers, Columbia University, New York, will discuss this topic.

For further news of the tentative technical program, see below.

Although October may be too cold for swimming, beaches in the fall are delightful places for relaxation. The Hotel Chamberlin at Old Point Comfort, Va., is located on the beach and registrants at the AIME-ASME Joint Solid Fuels Conference, October 9 and 10, will have an opportunity to enjoy the ocean-side facilities after sessions.

Program

October 9, am

V. Mansfield, ASME and
T. S. Spicer, AIME, *Co-Chairmen*

Coal Level Control and Stoppage Alarms: *A. Stock*, Stock Equipment Co., ASME.

Design Considerations for Pneumatic Coal Handling System: W. *Gruca*, Standard Forging Corp., ASME.

Specific Problems Connected With Handling and Disposing of Combustion Refuse from Solid Fuels: *L. E. Mylting*, Allen-Sherman-Hoff Pump Co., ASME.

Dock Handling of Bulk Materials: *R. C. Tench*, C&O Railway Co., AIME.

October 9, pm

Field trip arranged by G. G. Ritchie, C&O Railway.

October 10, am

Carl S. Dennis, ASME, and
H. B. Lammers, AIME, *Co-Chairmen*

Equipment and Procedure for Car Load Sampling: *A. Burr*, Cleveland Electric Illuminating Co., ASME.

Drying of Coal: *Charles Gordon*, Combustion Engineering Co., ASME.

Fundamental Studies in Bulk Solid Flow: *J. R. Lucas*, Ohio State University, AIME.

Relationship of Btu and F. C. in Evaluating Coking Coals: *H. J. Rose*, Bituminous Coal Research Inc., AIME.

October 10, pm

Frank Feeley, Jr., ASME, and
C. F. Hardy, AIME, *Co-Chairmen*

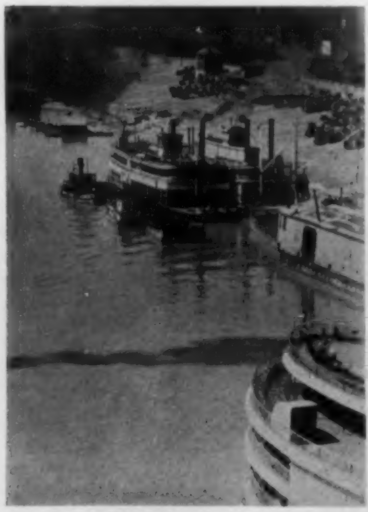
First Cyclone Furnace Fired Boiler in the Southeast: *W. L. Bross*, Greenwood Mills, ASME.

Start-up and Operating Experiences of Coal and Delayed Coke Fired Utility Boiler: *S. C. Brown*, Virginia Electric & Power Co., ASME.

Low Coke Button Bituminous Anthracite Equipment: *W. M. Sims* and *John Judden*, American Cyanamid Co., AIME.

Analysis of Low Set-High Set Spreader Stokers and Cyclone Furnaces: *A. L. Glaeser*, Hercules Powder Co., AIME.

An alternate paper will be Relation of Sized Coal Degradation to Petrographic Studies: *R. C. Neavel*, Indiana Geological Survey, AIME.



Mississippi showboats symbolize this Mid-America town, scene of the October meeting. The mighty river and the patron saint are sights for conventioneers.

Let's Meet in St. Louis For the Mid-America Conference in October

Meet Me in St. Louis has been an appealing theme since 1904, and it still is a good idea. Long the reigning city of the Mississippi, St. Louis today has become a convention magnet, with its many entertainment opportunities for added attractions.

This fall, October 23 to 25, the Mid-America Minerals Conference Committee has chosen the Chase-Park Plaza Hotels in St. Louis for their meeting place, with all the highlights of a resort area in an urban center. The hotels are conveniently located 15 min from air and rail transportation, the downtown area, and directly across from the beautiful Forest Park, which invites the visitor to golf or ride, go boating or play tennis, visit the

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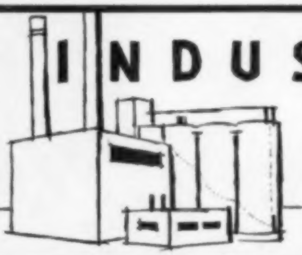

INDUSTRIAL MINERALS NEWSLETTER

Dear Members of IndMD:

Please take a long hard look at the new letterhead for your quarterly Newsletter. There are those who think it is fine and then there are those who think it a bit lacking in imagination. Letters in its support or suggestions or sketches for a completely different letterhead are solicited by your Secretary-Treasurer, John G. Broughton, Room 448, New York State Museum and Science Service, Education Building, Albany 1, N. Y., who has a mental bet that he will be doing well to receive more than two letters.

Your Executive Committee met in New York on May 7 and, at that time, approved the following slate of Divisional nominees for the AIME year beginning February 1959:

Included among plans for the AIME 1959 Annual Meeting in San Francisco is presentation of the first AIME Hal Williams Hardinge Award for achievement in the industrial minerals field. The award was made possible by a gift from Mrs. Hardinge to the Institute. She was IndMD's guest at their luncheon during the 1958 Annual Meeting in New York and is shown here with R. M. Grogan, Division Chairman this year.

Nominations

Chairman: John G. Broughton

Secretary-Treasurer: R. H. Feierabend

Vice Chairmen: J. B. Graham, Northeast; James L. Calver, Southeast; John A. Brown, Mid-Continent; D. A. Brobst, Rocky Mountain; R. F. Brooks, Southwest; A. J. Kauffman, Jr., Northwest; D. F. Hewitt, Canadian

Executive Committee (3 years): T. E. Gillingham, Jr.
John B. Patton
Lauren A. Wright

SME Director (3 years): John G. Broughton

SME Nominating Committee (year beginning July 1, 1959): Robert M. Grogan, Alternate, D. R. Irving; H. A. Meyerhoff, Alternate, G. W. Josephson

SME Admissions Committee: Lendall P. Warriner, R. T. Lassiter.

SME Transactions Editorial Committee: D. R. Irving

SME General Editorial Committee: Q. D. Singewald

SME Education Committee (3 years): Vernon E. Scheid

SME Mineral Economics Committee: G. W. Josephson

Bylaw Provisions

According to our new Bylaws, "Other nominations for the offices may be made and endorsed by ten members and forwarded in writing to the Secretary of the Society up to August 15 for publication in the October issue of MINING ENGINEERING. If such nominations are made, an election shall be held by letter ballot to be completed by December 31. If no such additional nominations are received, the candidates nominated by the Nominating Committee shall be considered elected and shall take office at the Annual Meeting."

Annual Meeting Plans

Ray Feierabend, Program Chairman for 1958, has given a preliminary report on the developments concerning IndMD papers to be given at the San Francisco meeting in February 1959. So far, the best plans have been laid in the commodity committee dealing with industrial waters (papers on subsidence, water laws, and water supplies—particularly in the western states); rate and radioactive minerals (which will hold a joint session with the Society of Economic Geologists. Here the question is one of determining which of many papers are of the highest quality—an unusual chore for a Commodity Chairman) and ceramic raw materials (also plenty of ideas and proffered papers—only waiting to be whipped into shape.)

Deadlines

Bob Grogan and Jack Fox want to impress authors with the deadline dates of August 15 for provisional titles, October 15 for abstracts and final titles, and November 1 for prepared copy.

Things are going full steam ahead for San Francisco, and it looks like a fine meeting on an Institute-wide basis.

John G. Broughton
Secretary-Treasurer
Industrial Minerals Division

Note: *There will be events at the Mid-America Minerals Conference, October 23 to 25, in St. Louis of particular interest to IndMD members—both field trips and sessions. See August MINING ENGINEERING for full details and technical program.*

Editor

Address news items to: John G. Broughton, IndMD Secretary-Treasurer, State Education Building, Room 448, Albany 1, New York


YOU CAN'T BARGAIN WITH SAFETY

ROCK IN THE BOX

Mining & Exploration Division

In accordance with **Article III**, *Section 2* of the M&E Bylaws, Nominating Committee announces nominations for officers to be installed in February at the Annual Meeting.

Lyman H. Hart, chief geologist for American Smelting and Refining Co., has been chosen as Chairman. A native of Iowa, Mr. Hart received his B.S. in chemical engineering from the University of Wisconsin and then earned a M.Sc. in geology there. He started with The Anaconda Co. and joined the U. S. Smelting Refining and Mining Co. in 1940, but has been with Asarco since 1946 as exploration geologist, assistant general manager Western Mining Dept., and resident engineer, before attaining his present position.

R. J. Lacy has been nominated for Assistant Chairman and is presently chief geophysicist for Asarco in Salt Lake City. He is a graduate of the University of Minnesota with a degree in mining engineering in 1937. He began as a mine geologist for Anaconda in Butte, Mont., and joined the California Co. as a geological observer on exploration parties in 1946. After a year of postgraduate work, he accepted the post of geologist with Asarco in 1948.

John G. Hall, manager of the Tahawus, N. Y., plant of National Lead Co., has been nominated as Vice Chairman. Born in Omaha, Neb., in 1917, he graduated from the University of Utah in 1939 and began to work for the U. S. Smelting Refining and Mining Co. In 1946 he was general superintendent of the Chief Consolidated Mining Co. operations in Eureka, Utah, and in 1952 he joined National Lead Co. Mr. Hall has been chairman of several AIME committees and is current Division Vice Chairman, publications.

Herbert E. Hawkes, Jr., the second nominee for Vice Chairman, is a New Yorker and Dartmouth graduate who spent three years in Canadian exploration geology and geophysics before returning to Massachusetts Institute of Technology for a Ph.D. He worked for 13 years with the U. S. Geological Survey, then with the Dept. of Geology and Geophysics at MIT, and finally on the staff of the University of California, where he is professor of exploration geology.

John C. Wangaard, superintendent of the Gary Mine of the Odanah Iron Co., Hurley, Wis., is the third nomination by M&E for the office of Vice Chairman. Born in Minnesota, Mr. Wangaard graduated from the University of Minnesota School of Mines in 1935 and joined the Lamaque Mining Co. Ltd. gold mining operations in Quebec, Canada. He joined Pickands, Mather & Co. in 1951 and has been appointed superintendent of their Gary and Peterson mines on the Gogebic Iron Range.

The Bylaws provide, "Other nominations for office may be made and forwarded in writing to the Secretary of the Society [J. C. Fox, SME, 29 W. 39th St., New York 18, N. Y.] up to August 15, for publication in the October issue of MINING ENGINEERING. If such nominations are made, letter ballots will be prepared for return not later than November 1. If no other nominations are received the candidates nominated by the Committee will be considered elected and will take office at the Annual Meeting [in February 1959 at San Francisco].

L. H. HART

R. J. LACY

J. G. HALL

H. E. HAWKES, JR.

J. C. WANGAARD

San Francisco Program

R. J. Lacy, M&E Vice Chairman, Programs, announces that plans are taking shape for M&E's program at the AIME San Francisco Annual Meeting in February 1959.

In the May issue of *Rock in the Box* (MINING ENGINEERING, p. 599) Herbert E. Hawkes, Jr., was incorrectly listed as Geophysics Unit Chairman. Mr. Hawkes is M&E Vice Chairman (Membership) and **Geochemistry Unit Chairman.** Robert J. Searls is Geophysics Unit Chairman.

Mr. Lacy wishes to remind Division members of deadlines for the meeting. Abstracts must have been sent to Mr. Lacy by September 24 and manuscripts must be sent to Jack Fox at SME headquarters by October 15. The SME Preprint Program proved highly successful last year and M&E members who will present papers are urged to meet these deadlines so that a maximum number of preprints will be available at the meeting.

M&E will have 12 sessions at the meeting in addition to the annual Jackling lecture. Present plans call for an average of four to five papers per session. With allowances for discussion and a break during each session, the papers presented should

(Continued on page 808)

Editor

Address news items to: John W. Chandler, American Metal Climax Inc., 61 Broadway, New York 6, New York.

DEPENDABLE

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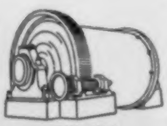
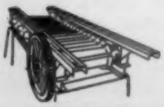
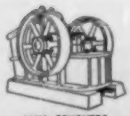

BALL MILLS


ROTARY KILNS


APRON FEEDERS


PRIMARY GYRATORY CRUSHERS


JAW CRUSHERS


SECONDARY GYRATORY CRUSHERS

MBD Announces Nominations for Divisional Offices in 1959

W. L. DOWDEY

The Minerals Beneficiation Division announces its slate of nominees to take office in February 1959.

The Nominating Committee has chosen Wayne Dowdey, Eimco Corp., Birmingham, for the office of Division Chairman; H. Rush Spedden, Union Carbide Corp., New York, for Associate Chairman; J. Walter Snavely, Chain Belt Co., Milwaukee, for a second year as Secretary-Treasurer; Neil Plummer, Kennecott Copper Corp., Garfield, Utah, as First Regional Vice Chairman; and Steve Erickson, M. A. Hanna Co., Cooley, Minn., as Second Regional Vice Chairman.

W. B. Stephenson of Allen-Sherman-Hoff Pump Co., Wynnewood, Pa., has been nominated for a Society of Mining Engineers Director (see p. 800).

Nominations for committee chairmen include the following: Henry W. Erickson, Port Washington, N. Y., for *Membership Chairman*; Bunting S. Crocker, Kilborn Engineering Ltd., Toronto, for *Papers & Publications*; and William Van Slyke, Cleveland Cliffs Iron Co., Taconite, Minn., for *Education*.

Unit Committee Chairmen nominees are: Charles E. Golson, Western Machinery Co., San Francisco, *Materials Handling*; Charles Sollenberger, Allis-Chalmers Mfg. Co., Milwaukee, *Crushing and Grinding*; William Mareton, Dorr-Oliver Inc., Englewood, Colo., *Solid-Fluid Separation*; Oscar Tangel, Battelle Memorial Inst., Columbus, Ohio, *Concentration*; L. A. Roe, International Mineral & Chemical Corp., Chicago, *Operating Control*; E. H. Crabtree, Colorado School of Mines Research Foundation Inc., Golden, Colo., *Chemical Process*; M. E. Volin, Michigan College of Mining & Technology, Houghton, Mich., *Pyrolysis & Agglomeration*; Al Wallach, Henry J. Kaiser (Canada) Ltd., Montreal, *Mill Design*; P. L. deBruyn, Massachusetts Institute of Technology, Cambridge, Mass., *Basic Science*.

There are two regular and two alternate nominees for the SME Nominating Committee. The regulars are W. B. Stephenson and Nathaniel Arbiter, and their respective alternates are H. Rush Spedden and Neil Plummer. Nominated for SME Admissions Committee are Robert Ramsey, St. Joseph Lead Co., New York, and Stuart A. Falconer, American Cyanamid Co., New York.

In accordance with the MBD Bylaws the Chairman of the Papers and Publications Committee, Bunting S. Crocker, also will serve as MBD representative on the SME Transactions Editorial Committee. The second Regional Vice Chairman, Steve Erickson, will serve as MBD representative on the SME General Editorial Committee. H. Rush Spedden, MBD Associate Chairman will be head of the MBD Program Committee and will also serve as a member of the SME Program Committee. Henry W. Erickson, MBD Membership Chairman, will also be MBD representative on SME Membership Committee. William Van Slyke, MBD Education Chairman, will also be on the SME Education Committee, and Frank W. McQuiston, Jr., Newmont Mining Corp., New York, will serve on the SME Mineral Economics Committee.

The MBD representative on the AIME Rossiter W. Raymond Award Committee will be the Chairman of the Division Papers & Publications Committee, Bunting S. Crocker.

H. R. SPEDDEN

Wayne Dowdey, who has been chosen as the nominee for Division Chairman, is regional manager for The Eimco Corp. in the Birmingham and Pittsburgh districts. A native of Alabama, he was brought up in the coal mining areas of that state, and attended Martha Berry College, Howard College, and Alabama Polytechnic Inst. Although as a student Mr. Dowdey had gained experience in coal mines, he began his professional career with Republic Steel Corp. in the blast furnaces in Birmingham. Before leaving Republic he had advanced to the position of mill superintendent at Spaulding, Ala. In 1945 Mr. Dowdey began his association with Eimco as sales engineer. Prior to attaining his present position, he had been manager of the southern district for the company. Long active in MBD, Mr. Dowdey has served the Division as secretary-treasurer, regional vice chairman, and associate chairman.

J. W. SNAVELY

H. Rush Spedden, nominee for Associate Chairman, a graduate of the University of Washington and the Montana School of Mines, is director of research, Union Carbide Ore Co., New York. He went to MIT as research assistant in 1940 and two years later took a leave of absence to serve as metallurgist with the U. S. Foreign Economic Administration in Bolivia. Following military service, he returned to MIT in 1946 as assistant professor of mineral engineering. Mr. Spedden joined Union Carbide in 1952 at the Metals Research Laboratories in Niagara Falls.

J. Walter Snavely, nominated as Secretary-Treasurer to fill the second year of a two-year term, is assistant division manager in the Conveyor and Process Equipment Div. of Chain Belt Co., Milwaukee. Born in 1906 in Sharpsburg, Md., he received a B.S. from the University of Wisconsin in 1927 and lives presently in Hales Corners, Wis. He has served on several AIME committees, acting as chairman of the MBD Materials Handling Committee in 1957. At the Chain Belt Co. he started as a student engineer and worked through various positions of field engineer and district manager to assistant division manager and manager of engineering until he obtained his present position. He is the author of numerous technical papers on bulk conveying, was a faculty member at the Conveyor Inst., University of Illinois, in 1953 and of the University of Wisconsin Engineering Inst. in 1957.

Plan Now for Hawaiian Sun and Sand in February

AIME announces a post-convention tour to Hawaii for ten days of sun and exotic entertainment after the Annual Meeting in San Francisco. A special flight on February 20 will carry the lucky vacationers to Honolulu for a round of sightseeing and leisure activities. Feasts and festivals, free time, and island tours fill the week's itinerary. Transportation by plane, limousine, and boat; luxurious hotel accommodations in Honolulu, Kona, and Coco Palms; special luncheons and dinners and featured programs are included in the total cost, $563.85 per person.

The holiday starts with a special welcome committee in Honolulu with music and leis and native Hawaiians. Rooms at the Hawaiian Village are ultra-modern, where guests may unwind Friday and Saturday, sleeping late or taking a dip. An afternoon tour includes Honolulu, Mt. Tantalus, the University of Hawaii, and the Monoa Valley. Sunday plans are open, with canoe and catamaran available, and an evening feast, the luau, with music and dancing.

After a lazy weekend the sightseeing begins with a 109-mile drive around the island of Oahu. Historic sites, the Mormon Temple, Pearl Harbor, and lush pineapple fields highlight the day. Tuesday again is free, and Wednesday the group flies to Hilo to visit the volcano area, flying from there on Thursday to the Island of Kauai to stay at the Coco Palms Hotel, and Friday morning a drive to Kalalau Lookout, 4000 ft high, overlooks the Napali Cliffs and Valley of the Lost Tribe. On Saturday a cruise up the Wailua River climaxes the tour before flying home.

The total price includes 12 meals, round trip tourist flight from San Francisco and all group transportation, admissions, lodging, and sightseeing outlined in the itinerary. Other meals, gratuities, laundry, and personal items not included. The tour is open to all Annual Meeting registrants.

Reservations should be made through the Theilig International Tours Inc., Daily News Plaza, Suite 2111, 400 W. Madison St., Chicago 6, Ill. The dates of the holiday are February 20 to March 1, 1959, and early reservations will be appreciated.

Mid-America

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world-famous zoo with its performing monkeys, or the Municipal Opera with its outdoor extravaganzas.

Around the corner are the smart stores of the Maryland Ave. shopping district. The heart of St. Louis is within easy reach, with its mighty river, its theaters, museums and ball games to attract the tourist.

The hotels themselves provide a wealth of entertainment. Lavish nightclubs like the Chase Club and the Zodiac Cocktail Lounge in the glass-enclosed Chase Roof penthouse invite dancing to name bands, with shows by topflight stars. On the Steeplechase Terrace, overlooking the swimming pool, light luncheons or afternoon cocktails are served outdoors to the tune of strolling musicians. The interconnected hotels have luxurious, air-conditioned rooms and facilities open to guests of the convention staying at either the Chase or Park Plaza.

Rock in the Box

(Continued from page 805)

run about 20 min each in length. The author then has a three-fold job in preparing his paper for the meeting: 1) he will write a 250 word abstract for use by the program chairman and for publication in MINING ENGINEERING, 2) he will condense his manuscript for 20-min presentation, and 3) he will send his completed manuscript to SME for preprinting and consideration for publication.

Program plans now call for three joint sessions: a mineral economics session in cooperation with SEG and IndMD; a session on rare and radioactive minerals, again in cooperation with IndMD and SEG; and an SEG-M&E geology session. Three and possibly four sessions will be devoted to exploration, with papers of interest to geologists, geochemists, and geophysicists. There will be five sessions for the Mining Units of the Division. In addition, of course, will be the annual Jackling Lecture.

Mining

As mentioned above, there will be five sessions for underground and open pit mining. This provides an opportunity for you to propose papers on these topics if you respond quickly. Write R. J. Lacy or the Unit chairmen to suggest outstanding papers that should be solicited or to submit a paper of your own.

Geophysics-Geochemistry

Robert Searls and Herb Hawkes report—The Geophysical and Geochemical Units, combined in operations for 1958, will continue in their efforts to promote wider interest in geophysics and geochemistry by the other units of the Division. This effort is being made in the publications plans for the year as well as in the program for San Francisco. The Committee is asking for suggestions from all phases of the mining industry, particularly geologists and operators, to help in providing this kind of a program.

If there are any phases of geochemistry or geophysics you would

(see facing page)

(Continued from facing page)

like to have included on either the San Francisco program or for consideration for future issues of MINING ENGINEERING, please drop a card to the Geophysics (R. J. Searls) or Geochemistry (H. E. Hawkes) Unit Chairmen.

Program arrangements for San Francisco are being handled by S. H. Ward (see new address below) and publications by George Rogers (Bear Creek Mining Co., 416 Acoma St., Denver, Colo.). These people would appreciate hearing from you.

Addresses

The following men are in charge of arrangements for the San Francisco program. Their addresses are given for your convenience in contacting them with any suggestions you may have.

Program Chairman, M&E—*R. J. Lacy*, American Smelting and Refining Co., 600 Crandall Bldg., Salt Lake City 1, Utah.

There is no definite program chairman for the Open Pit Mining Unit, so in the meantime address program business to R. J. Lacy or the Unit chairman, *W. A. Pakkala*, The Cleveland-Cliffs Iron Co., Hibbing, Minn.

There is no definite program chairman for the Underground Mining Unit, so, in the meantime, address program business to R. J. Lacy or the Unit Chairman, *J. M. Ehrhorn*, U. S. Smelting, Refining and Mining Co., Newhouse Bldg., Salt Lake City, Utah.

Program Chairman, Geology Unit—*S. E. Jerome*, Bear Creek Mining Co., 2121 South State St., Salt Lake City 15, Utah.

Program Chairman for the Geochemistry Unit—*Stanley H. Ward*, Office Mezzanine #15, King Edward Hotel, 37 King St., East, Toronto, Ont., Canada.

Program Chairman for the Geophysics Unit is also Stanley Ward. Incidentally, note his new address.

San Francisco Section Sponsors Paper Contest

The San Francisco Section is conducting a student prize paper contest this year in addition to the AIME annual national contest. The executive committee of the Section has also decided to raise the awards for the students at the University of California from $50 to $100.

The best graduate and undergraduate papers will each be awarded $100. The winning local papers then will be entered by the Section secretary in the national award contest. The papers are to cover a topic relating to some phase of mining, metallurgy or petroleum.

AIME OFFICERS:

PRESIDENT—AUGUSTUS B. KINZEL
PAST-PRESIDENT—GROVER J. HOLT
PRESIDENT-ELECT—HOWARD C. PYLE
VICE PRESIDENTS—E. C. BABSON, L. E. ELKINS, J. L. GILLSON, J. C. KINNEAR, JR., R. V. PIERCE, A. W. THORNTON
TREASURER—C. R. DODSON
SECRETARY—ERNEST KIRKENDALL

AIME STAFF:

ASS'T. SECRETARIES—J. B. ALFORD, H. N. APPLETON, J. C. FOX, R. W. SHEARMAN
ASS'T. TREASURER—JOHN LYNCH
FIELD SECRETARY & ASS'T SECY.—R. E. O'BRIEN, 707 NEWHOUSE BLDG., SALT LAKE CITY 1, UTAH

AIME NEWS

EUSEC Conference Held In New York in April

For the first time a conference of representatives of Engineering Societies of Western Europe and the United States convened in America. The Sixth Conference of EUSEC was held in New York, April 28 to May 2 at the Hotel Roosevelt with 23 societies from 14 countries represented.

In 1948 three British Engineering Societies invited the national societies of Europe and the United States to begin the organization which has since met in The Hague, Paris, and Copenhagen.

In New York the Sixth Conference was welcomed by Louis R. Howson, president, ASCE, who asserted that there can be no national boundaries for engineering. The agenda items included the important concerns of the profession that have been studied since the inception of EUSEC. The education of engineers, from pre-university background and selection, to practical training and professional recognition, was the primary topic.

AIME President Augustus B. Kinzel was in charge of the opening business session which covered elections of new members, review of past year's accomplishments, supply and demand for professional engineers, and engineering abstract services. Other subjects included the defining of engineering terms and the exchange of lecturers.

AIME Vice President J. L. Gillson was chairman of the fourth business session and President Kinzel presided at the closing formal dinner.

The retiring General Secretary of EUSEC formally transferred the management responsibilities of EUSEC to the U. S. societies. William Wisely, executive secretary of ASCE, was named general secretary and O. B. Shier, secretary of ASME, became editor of the EUSEC Bulletin. Participants in the New York Conference included the following:

Belgium, Société Royale Belge des Ingénieurs et des Industriels; *Denmark*, Dansk Ingeniorforening; *Finland*, Samarbetsdelegationen i Finland; *France*, Société des Ingénieurs Civils de France; *Germany*, Verein Deutscher Ingenieure; *Holland*, Koninklijk Instituut van Ingenieurs; *Italy*, Associazione Nacionale Ingegneri ed Architette Italiana; *Norway*, Den Norske Ingeniorforening; *Portugal*, Ordem dos Engenheires; *Spain*, Instituto de Ingenieros Civiles de Espana; *Sweden*, Svenska Teknologförening; *Switzerland*, Schweizerischer Ingenieur und Architekten Verein; *United Kingdom*, The Institution of Civil Engineers, The Institution of Mechanical Engineers, and Institution of Electrical Engineers; *United States*, ASCE, **AIME**, ASME, AIEE, AIChE, UET, ECPD, and EJC.

SME Nominations

(Continued from page 800)

1938 and in 1951 was elected vice president. Since 1956 he has been president of the company which deals in design and application of sand pumps to the mining and metal industry. Mr. Stephenson is the author of numerous technical papers and has served as chairman of MBD.

The Mining & Exploration Division has just announced the names of **Ewald Kipp** and **Sherman F. Kelly** as nominees for SME Directors. Their biographies and pictures will be published in August issue.

Participants in the Sixth EUSEC Conference in New York included representatives of 23 engineering societies in 14 countries, a fine example of international cooperation.

Exotic setting for the chuck wagon supper was the home of Charles Steen located on a mesa overlooking Moab. Host Steen, far right, is shown with a new acquisition, portrait painted and presented to him by Utah artist Dean Fausett. The supper fare must have rivaled the setting, if the appearance of the happy people at right can serve as a testimonial. First group is Ed Snyder, his daughter Mrs. Mitchel Melich, and Frank Burke, while to their right, supervising the sizzling steaks, are Philip Lindstrom, Robert Wyant, and Isobel Lindstrom.

AIME Uranium Section Is Symposium Host in Moab

The Third Annual Uranium Symposium was sponsored by the AIME Uranium Section at Moab, Utah, May 9 through 11. Special programs for the ladies filled the day while technical papers and field trips occupied the men.

Responsible for this extensive program were the officers of the Uranium Section, Gordon Miner, chairman, and Philip Lindstrom, chairman of the Symposium Committee.

Luncheons

The guest speaker for the opening luncheon, Karl Cohen, manager, advance engineering, Atomic Power Equipment Dept., General Electric Co., discussed the subject *Current Prospects for Economic Power in the United States.*

Friday evening brought a social pause with a cocktail hour and banquet, climaxed by a talk by the executive vice president of Thor-West Cliff Inc., Santa Fe, N. M., Don Lohbec, who spoke on *Extended Power Program—The Key to a Prosperous Uranium Industry.*

The symposium was highlighted Saturday noon by concurrent luncheons with corresponding afternoon sessions. The geology and mining luncheon presented the topic *Application of Geophysical Methods to Uranium Exploration and Mining.* A. J. Nichol, the luncheon speaker, is with the Century Geophysical Corp., Grand Junction, Colo.

A second luncheon honored the milling industry, with guest speaker Floyd Carman, assistant industrial relations director, National Lead Co., Monticello, Utah, who discussed *Personnel Policies.*

Technical Sessions

The sessions on the first afternoon presented several papers, among which were one by William B. Loring on *Ore Deposits of the Northern Big Indian District, San Juan County, Utah,* and one by M. Dane Picard on *Relationship Between Paradox Basin Oil to Structural Control.*

Other papers included topics such as *From Ore to Green Salts* by Harry Gardner, *Mining Practice in the Ambrosia Lake Area* by Ray Schultze, *Ore Control in Mining at the Lucky Mc Mine, Gas Hills Area,* by K. G. Wallace, and *Geological Studies in the Big Indian District, San Juan County, Utah,* by Vance Kennedy.

The Saturday morning sessions presented papers on the following topics: *Relationship of Paradox Basin Oil to Stratigraphy,* by Kenneth E. Carter, *Collapsed Structures Along the East Flank of the Spanish Valley Anticline, Grand and San Juan Counties, Utah,* by Willard P. Puffett, *Ore Occurrences of the Front Range, Including the Schwartzwalder Mine,* by Charles O. Parker, *Continental's Review of Three Phases of Uranium Mining* by John Roscoe and Maurice Brady, *Instrumentation in Uranium Mills* by Carl M. Marquardt, *Uranium Recovery by Solvent Extraction* by J. D. Lewis, and *Common Errors in Field and Laboratory Radiometry and a Graphical Approach to Uranium Analysis* by John Carman.

Among those participating in the milling forum on Saturday were Gillman Ritter, Robert Curfman (standing), Lewis A. Painter, W. A. Griffith, and Marcelle Smith. Uranium specialists presented interesting mill problems for discussion.

Head table guests at the welcoming luncheon on Friday were, left to right, Mitchel Melich, D. I. Hayes, C. A. Steen, Mr. and Mrs. Gordon Miner, Mr. and Mrs. Philip Lindstrom, Karl Cohen, and E. H. Snyder.

A more formal social occasion was the banquet on Friday. At the head table, left to right, were Mr. and Mrs. Philip Lindstrom, Payne Kibbe, C. E. Tuttle, Don Lohbec, Mr. and Mrs. Gordon Miner, Miles Romney, Karl Cohen, and E. J. Mayhew.

The geology and mining forum after the Saturday luncheon found E. H. Snyder moderating general discussion on innovations described briefly by members of the panel. Some of the topics touched on included *Economics of Blending and Crushing at the Cord Mine* by S. E. Craig, *Pillar Removal* by T. J. Barrett, *Blending of Uranium Ore for Greater Profits* by Edwin T. Wood, *Underground Dry Drilling Experiments* by Lloyd Fenske, *Long Hole Drilling* by Gordon E. Miner, and *Underground Haulage* by Russell Wood.

Specialists in uranium metallurgy presented interesting mill problems and unit operations at the Milling Forum, moderated by Lewis A. Painter. Topics covered included *Special Problems in Sampling Uranium Ore* by Gilman C. Ritter; *Crushing of Wet Ore at Western Nuclear* by Peter N. Thomas; *Solvent Extraction at Gunnison, Colo.*, by L. Hazen; *Advantages of Better Cycloning* by R. L. Curfman; *Chloride Elution in Resin-in-Pulp* by A. K. Veeder; and *Uranium Precipitation at Rare Metals Plant, Tuba City, Ariz.*, by W. A. Griffith.

Social Highlights

In addition to luncheons, banquet, and the chuck wagon supper, registrants had a chance to relax and enjoy *Tropicana*, a floor show in Las Vegas style. Famous show business personalities headlined the program and the big-name stars could probably take some hints from their local stand-ins. Hit of the show, at least for geologists in the audience, was the science lecturer who concluded his dissertation with the Moab area under tremendous pressure! These events took place after the banquet on Thursday evening.

Ladies Events

While their husbands were hearing papers and keeping abreast of the latest developments in uranium technology, the ladies were intent upon their own technical session—dedicated to the latest trends in the fashion world. Debate centered upon which innovation to adopt for full scale operation—chemise, sack, trapeze, or balloon. The summer fashion show followed luncheon at the Town and Country Club on Saturday. Sponsored by WAAIME members of the Uranium Section, the event was a product of local talent from models to entertainment.

Ladies were welcomed at all the social events during the Symposium. Many joined their husbands for the field trips on May 11.

Field Trips

The three-day event was climaxed by field trips on Sunday. The progressive tour began with a morning visit to the mill of Uranium Reduction Co. After a pause to acquire box lunches at the Arches Cafe, the trip continued to Utex Exploration Co. and the Mi Vida Mine, and wound up at the Radon Mine of Hecla Mining Co. Those registrants who made the trip had an opportunity to witness first hand some of the features of the three properties covered during the technical sessions on Friday and Saturday.

Map, Location, and Identification of AIME Local Sections

Alphabetical Listings Below Include the Name and Address of the Local Section Secretary or Secretary-Treasurer.

Subsections and/or Groups Are Given After Section Name.

50—Adirondack
Severn P. Brown, St. Joseph Lead Co., Balmat, N. Y.

1—Alaska
Douglas W. Huber, School of Mines, University of Alaska, P.O. Box 337, College, Alaska.

2—Arizona. Subsections: Ajo, Bisbee-Douglas, Morenci, Yavapi
C. L. Hoyt, P.O. Box 515, Ray, Ariz.

58—Arkansas
David J. White, P.O. Box 126, Bauxite, Ark.

66—Billings Petroleum
Don M. Madden, Mobil Producing Co., Box 2548, Billings, Mont.

3—Black Hills
Joel Waterland, Mine Dept., Homestake Mining Co., Central City, S. D.

4—Boston
J. H. Brown, Dept. of Metallurgy, Massachusetts Inst. of Technology, Cambridge 39, Mass.

78—California Coastal
Jack Biren, Continental Oil Co., Box 451, Ventura, Calif.

5—Carlsbad Potash
Ralph E. Littrell, National Potash Co., P.O. Box 731, Carlsbad, N. M.

6—Central Appalachian
Charles T. Holland, P.O. Box 836, Blacksburg, Va.

60—Central New Mexico
V. L. Hill, 1309 North Second, Grants, N. M.

7—Chicago
J. V. Russell, Republic Steel Corp., 11600 Burley Ave., Chicago 17, Ill.

8—Cleveland
Frank A. Zorko, Cleveland Welds, General Electric Co., Nela Park, Cleveland 12, Ohio.

9—Colorado. Subsections: Intermountain, Pikes Peak, MBD
Arthur L. Hill, National Fuse & Powder Co., 3801 Delgany St., Denver, Colo.

57—Colorado Plateau
T. S. Ary, 1340 Houston Ave., Grand Junction, Colo.

10—Columbia. Subsections: Snake River, Coeur d'Alene, Spokane
Carlos E. Milner, Jr., Box 1121, Spokane 10, Wash.

11—Connecticut
Robert S. Bray, Chase Brass & Copper Co., Waterbury, Conn.

55—Dallas
W. F. West, Estate of J. B. Stoddard, 500 Trinity University Bldg., Dallas, Texas.

12—Delta
F. J. Olivier, Humble Oil & Refining Co., P.O. Box 626, New Orleans, La.

65—Denver Petroleum, Subsections: Uintah Basin, Colorado-Nebraska
W. E. Bauman, Gulf Oil Corp., P.O. Box 2097, Denver, Colo.

13—Detroit
K. B. Valentine, Pontiac Motors Div., General Motors Corp., Pontiac 11, Mich.

14—East Texas
Hugh B. Barton, Humble Oil & Refining Co., Box 2025, Tyler, Texas.

15—El Paso
Guy E. Ingersoll, Texas Western College, El Paso, Texas.

71—Evangeline
Jack Mahan, Jr., Pan American Petroleum Corp., Box 583, Lafayette, La.

45—Florida
Harvey B. Hardy, Georgia Iron Works, P.O. Box 509, Bartow, Fla.

54—Fort Worth
Walter L. Hahn, The Texas Co., Continental Life Bldg., Box 1720, Fort Worth, Texas.

77—Four Corners Petroleum
Thomas A. Dugan, Pacific Northwest Pipeline Corp., 405½ West Broadway, Farmington, N. M.

73—Great Bend
Stephen F. Hoss, Perforating Guns Atlas Corp., Box 259, Great Bend, Kan.

16—Gulf Coast
Bob Diggs Brown, Halliburton Oil Well Cementing Co., 512 Esperson Bldg., Houston 2, Texas.

61—Hobbs
Robert N. Miller, Tidewater Oil Co., Box 547, Hobbs, N. M.

62—Hugoton
Gale T. Bradshaw, Schlumberger Well Surveying Corp., Box 512, Liberal, Kan.

68—Illinois Basin Petroleum
Elmer A. Milz, Shell Oil Co., Petroleum Bldg., Centralia, Ill.

17—Kansas
James J. Jamieson, Gulf Oil Corp., Box 2233, Wichita, Kan.

18—Lehigh Valley
Noel N. Moebs, Geological Dept., The New Jersey Zinc Co., R.D. #1, Center Valley, Pa.

52—Lou-Ark
Paul S. Clinkenbeard, Dowell Inc., 1102 Beck Bldg., Shreveport, La.

19—Mid-Continent
H. Arthur Nedom, Amerada Petroleum Corp., Tulsa, Okla.

20—Minnesota. Subsections: Mining, Minerals Beneficiation
R. L. Bennett, Research Laboratory, Oliver Iron Mining Div., 4832 Grand Ave., Duluth, Minn.

56—Mississippi
Wilbur Lilly, Gulf Oil Corp., Box 1269, Jackson, Miss.

21—Montana
C. J. Hicks, The Anaconda Co., 526 Hennessy Bldg., Butte, Mont.

22—Nevada. Subsections: Reno, Southern Nevada, Eastern Nevada
John G. Smith, Box 141, Ruth, Nev.

23—New York. Groups: Physical Metallurgy, Powder Metallurgy
David T. Steele, American Metal Climax Inc., 61 Broadway, New York 6. N. Y.

67—New York Petroleum
Todd L. Tapp, California Texas Oil Co., 380 Madison Ave., New York 17, N. Y.

64—Niagara Frontier
J. D. Roach, TAM Div., National Lead Co., Niagara Falls, N. Y.

25—North Pacific
Merrill C. Teats, American Smelting & Refining Co., Tacoma Smelter, Tacoma, Wash.

24—North Texas
Don V. Hester, The Texas Co., Box 600, Wichita Falls, Texas

26—Ohio Valley
J. R. Lucas, Ohio State University, Columbus, Ohio.

27—Oklahoma City
Eugene N. Bennett, Pan American Petroleum Corp., P.O. Box 1654, Oklahoma City, Okla.

28—Oregon
Don W. Johnson, Reynolds Metals Co., Longview, Wash.

63—Panhandle
Albert S. Knox, Gulf Oil Corp., Box 751, Borger, Texas.

29—Pennsylvania-Anthracite
Emerson H. Todd, American Chain & Cable Co., 271 S. Pennsylvania Ave., Wilkes-Barre, Pa.

30—Permian Basin
J. B. Markolf, Schulmberger Well Surveying Corp., Route 1, Box 5X, Midland, Texas.

31—Philadelphia
James M. B. Keyser, Allen-Sherman-Hoff Pump Co., 259 East Lancaster Ave., Wynnewood, Pa.

32—Pittsburgh. Subsections: Petroleum; Groups: Minerals Industry, Institute of Metals
R. S. Crowell, U.S. Steel Corp., Clairton Works, Clairton, Pa.

81—Roswell Petroleum
Rex C. Cabaniss, Box 845, Roswell, N. M.

33—St. Louis
Gordon M. Bell, Alcoa Research Laboratories, P.O. Box 497, East St. Louis, Ill.

34—San Francisco
L. A. Norman, Jr., 41 Sutter St., Room 709, San Francisco, Calif.

59—San Joaquin Valley
A. J. Horn, Standard Oil Co. of California, 11-C Camp, Taft, Calif.

80—Snyder
E. L. Epley, Magnolia Petroleum Co., Box 815, Snyder, Texas.

53—South Plains
R. J. Boren, 1307 East Hester St., Brownfield, Texas.

35—Southeast. Subsections: Carolina, Eastern North Carolina, Knoxville Area
L. S. Chabot, Jr., 2705 Shades Crest Rd., Birmingham 9, Ala.

36—Southern California. Subsections: Southern Sierra
A. T. Cape, 724 South Victory Blvd., Burbank, Calif.

69—Southern California Petroleum
W. F. Cerini, Union Oil Co. of California, 9675 S. Santa Fe Springs Rd., Whittier, Calif.

37—Southwest Texas. Subsections: Austin-San Antonio
W. J. Bielstein, Humble Oil & Refining Co., P.O. Box 1271, Corpus Christi, Texas.

48—Southwestern Alaska
William Powell, Territorial Dept. of Mines, 329 Second Ave., Anchorage, Alaska.

38—Southwestern New Mexico
David W. Boise, 917 West St., Silver City, N. M.

44—Spindletop
Carl B. Rush, Pan American Petroleum Corp., Box 5038, Beaumont, Texas.

39—Tri-State
Hugh Wright, Tri-State Zinc & Lead Ore Producers Assn., P.O. Box 36, Picher, Okla.

74—Upper Mississippi Valley
Thomas E. Mullens, P.O. Box 165, Platteville, Wis.

40—Upper Peninsula
Roy W. Drier, McNair Hall, Michigan College of Mining & Technology, Houghton, Mich.

75—Uranium
R. W. Unger, 477 W. Andrea Ct., Moab, Utah.

41—Utah
P. H. Ensign, Kennecott Copper Corp., Arthur Plant, Garfield, Utah.

42—Washington, D. C.
Albert E. Schreck, 726 Jackson Ave., Falls Church, Va.

49—West Central Texas
L. D. Webster, Katz Oil Co., 428 Petroleum Bldg., Abilene, Texas.

43—Wyoming
D. L. Garthwaite, Pan American Petroleum Corp., P.O. Box 40, Casper, Wyo.

83—Wyoming Mining and Metals
John Atkins, 306 Antelope Dr., Riverton, Wyo.

Foreign Sections

76—Caracas Petroleum
E. A. Moore, Cia. Shell de Venezuela, Apartado 809, Caracas, Venezuela.

79—CIM-AIME Calgary Petroleum Engineering Section of the Petroleum and Natural Gas Div., CIM
J. R. Lyon, Shell Oil Co., Box 100, Calgary, Alberta, Canada.

82—CIM-AIME Edmonton Petroleum Engineering Section of the Petroleum and Natural Gas Div., CIM
V. E. Bohme, Oil & Gas Conservation Board, Room 330, Natural Resources Bldg., Edmonton, Alberta, Canada.

70—Eastern Venezuela Petroleum
Roger D. West, Mene Grande Oil Co., Apartado 3947, Caracas, Venezuela.

51—Lima, Peru
Walter E. King, Av. Santa Cruz 331, Miraflores, Lima, Peru.

47—Mexico
John T. Carty, Dolores 17-901, Mexico 1, D.F., Mexico.

46—Philippine
Nestorio N. Lim, 26 Montreal St., Univ. Subd. Cubao, Quezon City, P.I.

72—Western Venezuela Petroleum
R. L. Seay, Jr., c/o Richmond Exploration Co., Apartado 95, Maracaibo, Venezuela.

Local Section Membership Chairmen

List includes only Sections to which SME members belong.

50—Adirondack
Charles R. Barton, Jr., Barton Mines Corp., North Creek, N. Y.

1—Alaska
D. P. Colp, 644 8th Ave., Fairbanks, Alaska.

2—Arizona
Reed F. Welch, American Smelting & Refining Co., 810 Valley National Bldg., Tucson, Ariz.

58—Arkansas
Jack C. McFarlin, Ore Control Engineer, Reynolds Mining Corp., Bauxite, Ark.

3—Black Hills
Rex Tario, Homestake Mining Co., Lead, S. D.

4—Boston
* J. H. Brown, Dept. of Metallurgy, Massachusetts Inst. of Technology, Cambridge 39, Mass.

5—Carlsbad Potash
J. E. Tong, Box 67, Carlsbad, N. M.

6—Central Appalachian
G. R. Spindler, Director, School of Mines, West Virginia University, Morgantown, W. Va.

60—Central New Mexico
R. J. Stoehr, 208 Smith St., Grants, N. M.

7—Chicago
E. C. Rudolphy, Chief Development Metallurgist, U.S. Steel Corp., South Works, 3426 E. 89th St., Chicago, Ill.

8—Cleveland
* Frank A. Zorko, Cleveland Welds, General Electric Co., Nela Park, Cleveland 12, Ohio.

9—Colorado
Fred L. Smith, Manager, Mining Div., Colorado School of Mines Research Foundation Inc., Golden, Colo.

57—Colorado Plateau
J. William Hasler, 1350 N. 18th, Grand Junction, Colo.

10—Columbia
Ed Oman, Manager, Mining Dept., Western Machinery Co., Spokane Div., Spokane, Wash.

11—Connecticut
John P. Lynch, Jr., Research Assistant, American Brass Co., Waterbury, Conn.

55—Dallas
Margaret Keiles, Assistant Research Chemist, Atlantic Refining Co., Box 2815, Dallas, Texas.

12—Delta
Dale H. Aunspaugh, Gulf Refining Co., Houston Products Div., P.O. Drawer 37, Harvey, La.

13—Detroit
R. A. Wilde, Eaton Manufacturing Co., 9771 French Rd., Detroit 13, Mich.

15—El Paso
Robert McGeorge, Ore Buyer & Assistant to Manager, American Smelting & Refining Co., 700 Crandall Bldg., Salt Lake City, Utah.

45—Florida
James L. Cox, P.O. Box 867, Bartow, Fla.

16—Gulf Coast
Patrick Broussard, Assistant Div. Engineer, Halliburton Oil Well Cementing Co., 512 Esperson Bldg., Houston, Texas.

17—Kansas
William R. Franey, District Engineer, Stanolind Oil & Gas Co., Room 1039, First National Bank Bldg., Wichita, Kansas.

18—Lehigh Valley
A. T. Kaufman, Bethlehem Steel Corp., Room 1307, Main Office, 3 St., Bethlehem, Pa.

19—Mid-Continent
Virgil J. Berry, Jr., Group Supervisor, Stanolind Oil & Gas Co., Research Dept., Tulsa, Okla.

20—Minnesota
R. C. Ferguson, Hardinge Co. Inc., York, Pa.

56—Mississippi
James M. Otts, Jr., Zone Petroleum Engineer, Gulf Oil Corp., Box 638, Laurel, Miss.

21—Montana
Koehler Stout, Assistant Professor of Mining Engineering, Montana School of Mines, Butte, Mont.

22—Nevada
A. L. Engel, U.S. Bureau of Mines, 1605 Evans Ave., Reno, Nev.

23—New York
George P. Lutjen, District Manager, Coal Age and Engineering & Mining Journal, 500 Fifth Ave., New York, N. Y.

64—Niagara Frontier
C. H. Emery, 58 Windermere Rd., Lockport, N. Y.

25—North Pacific
Martin L. Plass, Assistant General Superintendent, American Smelting & Refining Co., Box 1111, El Paso, Texas.

26—Ohio Valley
W. J. King, Kaiser Aluminum & Chemical Corp., Newark, Ohio.

28—Oregon
Ralph Ferguson, Gladding McBean & Co., 110 S.E. Main St., Portland, Ore.

29—Pennsylvania-Anthracite
J. T. Griffiths, 340 N. Bromley Ave., Scranton 4, Pa.

31—Philadelphia
Robert B. Brackin, Engineering Dept., Du Pont de Nemours & Co., Wilmington, Del.

32—Pittsburgh
* R. S. Crowell, U.S. Steel Corp., Clairton Works, Clairton, Pa.

33—St. Louis
V. W. Buys, 1915 Washington Ave., St. Louis 3, Mo.

Numerical Local Section Code to Map

1	Alaska	29	Penn.-Anthracite	57	Colorado Plateau
2	Arizona	30	Permian Basin	58	Arkansas
3	Black Hills	31	Philadelphia	59	San Joaquin
4	Boston	32	Pittsburgh	60	Central New Mexico
5	Carlsbad Potash	33	St. Louis	61	Hobbs
6	Central Appalachian	34	San Francisco	62	Hugoton
7	Chicago	35	Southeast	63	Panhandle
8	Cleveland	36	Southern California	64	Niagara Frontier
9	Colorado	37	Southwest Texas	65	Denver Petroleum
10	Columbia	38	Southwestern New Mexico	66	Billings Petroleum
11	Connecticut	39	Tri-State	67	New York Petroleum
12	Delta	40	Upper Peninsula	68	Illinois Petroleum Basin
13	Detroit	41	Utah	69	So. California Petroleum
14	East Texas	42	Washington, D. C.	70	Eastern Venezuela Petroleum
15	El Paso	43	Wyoming	71	Evangeline
16	Gulf Coast	44	Spindletop	72	West Venezuela
17	Kansas	45	Florida	73	Great Bend
18	Lehigh Valley	46	Philippine	74	Upper Mississippi
19	Mid-Continent	47	Mexico	75	Uranium
20	Minnesota	48	Southwestern Alaska	76	Caracas
21	Montana	49	West Central Texas	77	Four Corners
22	Nevada	50	Adirondack	78	California Coastal
23	New York	51	Peru	79	CIM-AIME Calgary
24	North Texas	52	Lou-Ark	80	Snyder
25	North Pacific	53	South Plains	81	Roswell
26	Ohio Valley	54	Fort Worth	82	CIM-AIME Edmonton
27	Oklahoma City	55	Dallas	83	Wyoming Mining & Metals (Location not given on map)
28	Oregon	56	Mississippi		

34—San Francisco
L. Kenneth Wilson, American Smelting & Refining Co., 405 Montgomery St., San Francisco 4, Calif.

59—San Joaquin Valley
J. H. Sutton, 2908 Berger St., Bakersfield, Calif.

35—Southeast
R. S. White, 249 Flint Dr., Fairfield, Ala.

36—Southern California
John H. Eggers, 8121 West Blvd., Inglewood 4, Calif.

37—Southwest Texas
James J. McMahon, Shell Oil Co., P.O. Box 1861, Corpus Christi, Texas.

48—Southwestern Alaska
Martin W. Jasper, Territorial Dept. of Mines, Box 2139, Anchorage, Alaska.

38—Southwestern New Mexico
Robert W. Shilling, Kennecott Copper Corp., Box 966, Santa Rita, N. M.

39—Tri-State
(Tri-State) Claude O. Dale, Assistant General Manager, Mining & Smelting Div., Eagle Picher Co., Miami, Okla. (SME Mining & Exploration Div.) Richard C. Lundin, Eagle Picher Co., Cardin, Okla.

74—Upper Mississippi Valley
John M. Hague, 521 Rountree Ave., Plattville, Wis.

40—Upper Peninsula
W. Seppanen, Pickands Mather & Co., Caspian, Mich.

75—Uranium
Edwin Wood, Hidden Splendor Mining Co., Moab, Utah.

41—Utah
E. K. Olson, Jr., Utah Copper Div., Kennecott Copper Corp., Salt Lake City, Utah.

42—Washington, D. C.
* Albert E. Schreck, 726 Jackson Ave., Falls Church, Va.

43—Wyoming Mining and Metals
Robert Ford, 206 S. Broadway, P.O. Box 426, Riverton, Wyo.

70—Eastern Venezuela Petroleum
Jay G. Hautemen, AZ Export, Apartado 4026, Puerto La Cruz, Venezuela.

47—Mexico
Georges Ordonez, Avenida Juarez No. 134, Mexico D.F., Mexico.

46—Philippine
* Nestorio N. Lim, 26 Montreal St. Univ. Subd. Cubao, Quezon City, P.I.

* Refers to Secretary of Section where a Membership Chairman is not listed.

Around the Sections

• The **Open Pit Division** of the Arizona Section held a day-long meeting on April 25 at the Pima Mine near Tucson, Ariz. An inspection of the Pima Pit operation was the feature of the morning session. The afternoon technical session took place at El Conquistador Hotel in Tucson.

Features of the technical session were a paper on the use of turbocharger haulage trucks by Robert Watts, a paper on primary blasting with prilled ammonium nitrate by Robert Means, and a discussion of recent developments in mining in Africa by A. A. Friedman. Walter E. Heinrichs, Jr., was presented with an AIME award for having obtained 15 new members for the Institute.

• W. P. Dyrenforth, manager of sales for Carpco Manufacturing Inc., Jacksonville, Fla., was the principal speaker at the dinner meeting of the **Minnesota Beneficiation Subsection** of the Minnesota Section. Mr. Dyrenforth's subject was *Unusual Methods of Concentrating Iron Ores.* The meeting was held at the servicemen's center, Chisholm, Minn., Mesabi iron range, on April 23.

• The **Colorado MBD Subsection,** Colorado Section, held a meeting on May 24 at Colorado Springs which included golf, swimming, tennis, and various lectures. Marshall Downey of Southwest Potash Corp. spoke on *Things About Potash.* Edward S. Howell of the Bagdad Copper Corp. discussed the *Description of the Bagdad FluoSolids and Electrometallurgical Pilot Plant.* Kendrick Lentz of Union Carbide Nuclear Corp. talked about *The Union Carbide Nuclear's Plant at Maybell, Colorado.* A film was shown on Reserve Mining Co.'s taconite processing and pelletizing project.

• The **San Francisco Section** held a meeting on April 9 at the Engineers Club. E. A. Hassan, Jr., manager, Mineral Resources Dept., Kaiser Aluminum & Chemical Co., presented color films on Kaiser's Jamaica mining operations and domestic production facilities. A question and answer period followed the film.

Alfred B. Sabin was the speaker at the May 14 meeting of the San Francisco Section, held at the Engineers Club. Mr. Sabin's topic was *Political Trends Affecting Mining in Indonesia.*

• The **Mining Society,** Pennsylvania State University Student Chapter's annual career opportunities forum was held on April 30 to give first-hand information on the problems in the industrial community that face the college graduate. The list of panelists represented five segments of the mineral industry.

The *Mining Society*, AIME Student Chapter at the Pennsylvania State University, held its annual career opportunities forum on April 30 at the university. Among those participating were, seated: William Crentz, USBM, and Harold J. Rose, Bituminous Coal Research Inc. Standing, left to right, are: H. B. Charmbury, faculty sponsor, Mining Society; John Todhunter, Barnes and Tucker Coal Co.; Ted Spicer, professor, Fuel Technology Dept., Penn State; Robert H. Milligan, Joy Manufacturing Co.; S. C. Houghton, Bethlehem Steel Corp.; Howard Hartman, head, Mining Dept., Penn State; and Frank D. Hoyt, Mining Dept., Penn State. Dr. Charmbury was discussion moderator and panel members included Messrs. Crentz, Houghton, Milligan, Rose, and Todhunter, each representing an important segment of the mineral industries.

• The **Adirondack Section's** first meeting of the year on April 26 featured a tour of the Power Project of the New York Power Authority and the St. Lawrence Seaway at Massena, N. Y. Special guests for the dinner meeting that followed were Al Mallette, the host; J. W. Woomer, President-Elect of the Society of Mining Engineers; and J. C. Fox, Secretary of SME. Mr. Mallette answered questions on the projects, Mr. Fox outlined the organization of AIME, and Mr. Woomer spoke on the one-world aspect of mining and of the impact of high speed mining techniques on ore reserves, on management, and on milling methods.

Busloads of Canadians joined the Adirondack Section as guests of the Jones and Laughlin Steel Corp. open pit mine at Star Lake on May 24. A tour of the plant, golf, cocktails, and dinner provided get acquainted time for the two groups.

The winners of the student essay contest have been announced. Republic Steel Corp. and Cabot Carbon Co. Minerals Div. sponsored the contest to stimulate career interest in the mineral industry. The talented high school freshmen who won are: Nancy Lee Smith, Mineville, first prize; Alora Leigh, North Creek, second; Joan Walden, North Creek, third. Honorable mention was awarded to Albert Isereau, Clifton-Fine; Margaret Beatty, Gouverneur; and Joseph Accarino, Augustinian.

• The **Columbia Section** had joint meeting with the **Student Chapters** of the **University of Idaho** and **Washington State College** on May 16. A banquet was the background for talks on mining, metallurgy, and geology.

• The **Lehigh Valley Section** held their annual members and ladies meeting at the Saucon Valley Country Club, Bethlehem, Pa., on May 23. Cocktails and a dinner-dance were the attractions of the evening.

• The **Mexico Section** met on May 12 at the University Club, Mexico City, Mexico. Guillermo P. Salas gave an informal description of his visits to the meeting for the Geological Chart in Paris and the Brussels World's Fair.

Walter R. Hibbard, President of The Metallurgical Society, was the guest speaker at the dinner meeting of the *Southern Nevada Subsection*, Nevada Section, at the Hacienda Hotel, Las Vegas, on May 7. Dr. Hibbard's topic was Russian metallurgy and his illustrated account included a description of the life and times in Russia, a topic of particular interest to the many ladies present. Shown, left to right, are L. T. Eck, program chairman; D. L. Day, Subsection secretary-treasurer; Dr. Hibbard; L. J. Hartzell, Subsection chairman; and R. V. Lundquist, vice chairman.

• The **Southern Nevada Subsection** of the Nevada Section held a dinner meeting at Fong's Garden, Las Vegas, Nev., on March 21. Featured speaker was Melvin W. Carter, a sanitary engineer and member of the U. S. Public Health Service attached to the Atomic Energy Commission in Las Vegas. Mr. Carter described the various methods of detecting and measuring atomic radiation, and brought the members up to date on the hazards of the different types of radiation.

• Under the direction of the **Anderson Carlisle Society,** student affiliate of AIME, *Engineering Day* was held on the campus of the Montana School of Mines, Butte, Mont., on May 15 and 16. Activities were primarily a student responsibility, and were under the general chairmanship of Gordon R. Parker, president of the society. Essentially an open house, Engineering Day was designed to acquaint the people of Montana with the facilities, equipment, and types of education Montana School of Mines has to offer. Displays and demonstrations were prepared to indicate the role played by various departments of the school in the training of students. Movies were shown, and refreshments were served.

• The **El Paso Section** held a joint meeting with Kidd Mining Club of Texas Western College, on April 17 at El Paso, Texas. After a bean feed dinner, senior metallurgy students at Texas Western College gave reports on their research problems.

• Edward Bonner, assistant general superintendent, The Anaconda Co., was the guest speaker at the April 21 meeting of the **Montana Section.** His subject was *Ammonium Nitrate Blasting at the Berkeley Pit.*

• The dinner meeting of the **New York Section** was held on March 20 at the Mining Club. The guest speaker, Alvin W. Knoerr, editor of *Engineering & Mining Journal,* discussed *What We Can Do to Achieve Better Metal Prices.*

• **The Utah Section** and the **University of Utah Student Chapter** of AIME were joint hosts at the April 15 meeting of the Utah Section, held at the New Union Building, University of Utah campus, Salt Lake City. The guest speaker was Joseph L. Gillson, Vice President and Director of AIME and chief geologist of E. I. duPont de Nemours & Co., Industrial Minerals Div. Dr. Gillson's topic was *Job Opportunities in the Industrial Minerals Field.* A special feature of the meeting was the presentation of lapel pins to 25 living past-chairmen of the Utah Section.

• The **Montana Section** sponsored a banquet on May 9 as one of the highlights of the symposium on hydraulic stope fill at the Montana School of Mines. The after-dinner address was given by Chester Steele, vice president, Western Operations, The Anaconda Co., on *Cooperation —the Keynote of Industry and Education.*

• The **Pennsylvania-Anthracite Section** met in Hazelton, Pa., on April 25 to hear James Eckerd, chief, Branch of Preparation and Utilization, U. S. Bureau of Mines, Anthracite Experimental Station. *Crushing Domestic Sizes of Anthracite to Produce Steam Sizes* was Mr. Eckerd's topic, which he illustrated with charts and graphs.

• Ladies Night for the **Oregon Section** was April 25. William E. Caldwell of Oregon State College spoke on his recent trip around the world.

On May 16 a dinner meeting was held at which R. G. Vervaeke, general manager of Chemical Lime Co., Baker, gave an illustrated talk on *The Chemical Lime Story.*

Personals

Leo Gluck, retired mining engineer of New York, is among 13 outstanding alumni of Washington University, St. Louis, who were honored at Founders Day ceremonies on the campus in February. A graduate of the University in 1889 with the degree of engineer of mines, Mr. Gluck, during his long career as a mining engineer, has served as a consultant in England, France, and Germany, and at one time was assistant to the president of the Pittsburgh Coal Co. At various times he has lectured at the University of Minnesota, Carnegie Institute of Technology, the University of Pennsylvania, and the University of Kentucky.

A. J. Perantoni recently assumed new sales duties with the Organic Chemicals Div., American Cyanamid Co., in the Explosives Dept. Mr. Perantoni, who has been with the Advertising Dept. of the division since 1953, will be located at the division's sales headquarters in Latrobe, Pa.


J. D. MacKENZIE


S. H. EKEFALK

John D. MacKenzie, formerly vice president in charge of smelting and refining operations, has been elected president of American Smelting & Refining Co. He succeeds **R. W. Vaughan,** who has been elected vice chairman of the board. **R. L. Jourdan,** manager of the ore department since 1941, has been elected a vice president of the company.

S. H. Ekefalk and **Erik Ryd** have been appointed deputy managing directors of Atlas Copco AB, Stockholm, Sweden. Mr. Ekefalk was formerly technical director and vice president of the Swedish State Power Board. Mr. Ryd, who has been with Atlas Copco since 1923, was most recently technical director of the company.

Gordon L. Bell, formerly assistant professor of geology at the University of North Dakota, has now become soils engineer for the North Dakota State Highway Dept. He is principally concerned with the construction of twin embankments for the Interstate Highway which will cross North Dakota.


E. RYD


J. H. WREN

James H. Wren, manager of J. H. Wren & Co., consulting mining engineers, Sacramento, Calif., left in May for Ecuador, where he is in charge of a field party examining and evaluating an extensive area of potential placer gold bearing gravels suitable for high volume bucket line dredging.

J. Matthew Blair has been promoted to safety director at the Vesta-Shannopin Coal Div. of Jones & Laughlin Steel Corp., to replace **Thomas Park,** who will be retiring on October 1. **Donald C. Howe,** formerly mining industrial engineer for the division, succeeds Mr. Blair as superintendent, and **Walter Weaver,** formerly assistant mine industrial engineer, will replace Mr. Howe.

Leslie S. Wilcoxson has been elected a member of the board of directors of Babcock-Wilcox & Goldie-McCulloch Ltd. Mr. Wilcoxson is vice president in charge of the Boiler Div. and a director of the Babcock & Wilcox Co.

A. H. Lindley, Jr., formerly special studies coordinator for the Foreign Minerals Div., U. S. Bureau of Mines, has become mineral advisor for Lehman Bros., New York.

G. C. Holton has been named manager of American Cyanamid Co.'s new combined unit known as the Explosives and Mining Chemicals Dept. **J. R. Burkett** and **F. A. Griffin** have become assistant managers of the department.

Spencer R. Milliken, formerly with the Aluminum Co. of America Research Laboratories, New Kensington, Pa., has been appointed research and development-sales staff coordinator of Foote Mineral Co.

Fred M. Hakenjos has been named manager of the newly created Chemical Propulsion Div. of the Explosives Dept., Hercules Powder Co., Wilmington, Del. Mr. Hakenjos had previously been smokeless powder sales manager.

William Eathorne, health and safety engineer for the U. S. Bureau of Mines, gave a lecture-demonstration to the Westmoreland County Technical Soc., Latrobe, Pa., on the industrial hazards of static electricity. To illustrate his point, Mr. Eathorne lighted a cigarette, energized a fluorescent lamp, and exploded a jar of natural gas, all with static developed by a simple belt drive.

Officers of the American Zinc Inst. for 1958-1959 are: president, **S. D. Strauss,** American Smelting & Refining Co.; vice presidents, **J. D. Bradley,** The Bunker Hill Co.; **Clarence Glass,** Anaconda Sales Co.; and **H. L. Young,** American Zinc Sales Co.; treasurer, **G. H. LeFevre,** U. S. Smelting Refining & Mining Co.; executive vice president and secretary, **J. L. Kimberley.** Directors elected for the term expiring in 1961 are **H. D. Carus,** Matthiessen & Hegeler Zinc Co.; **C. M. Chapin, Jr.,** St. Joseph Lead Co.; **R. G. Kenly,** The New Jersey Zinc Co.; **E. H. Klein,** The New Jersey Zinc Co.; **J. J. Lennon,** American Metal Climax Inc.; **F. S. Mulock,** U. S. Smelting Refining & Mining Co.; **R. F. Orr,** Athletic Mining & Smelting Co.; **O. A. Rockwell,** Eagle-Picher Co.; **C. N. Waterman,** American Smelting & Refining Co.; and **H. L. Young,** American Zinc, Lead & Smelting Co.

Howard Goodman has been elected president and chief executive officer of Goodman Manufacturing Co., Chicago. He succeeds **William E. Goodman,** formerly president and chairman of the board, who will continue in the latter capacity.


H. GOODMAN


G. D. HOHLER

Gordon D. Hohler, formerly office supervisor and purchasing agent of Ressurection Mining Co., Leadville, Colo., has been appointed to the Denver district sales staff of Atlas Copco Pacific Inc.

James A. Norden, Louis Buchman, and **L. S. Breckon** have entered into an agreement with The Bunker Hill Co., Kellogg, Idaho, for the sale of the Red Bird Mine near Clayton, Idaho. The mine has been operated by the partnership since 1947, under the direction of Mr. Norden.

Russell A. Barke has been promoted to assistant mining engineer-property in the Hibbing-Chisholm district of Oliver Iron Mining Div., U. S. Steel Corp.

Paul F. Patchick is now geologist in charge of the bulk metallurgical sampling program of low-grade manganese ores in Batesville, Ark., district, American Potash & Chemical Corp. He was formerly a laboratory associate and instructor in mineralogy in the Dept. of Geology, University of Southern California.

J. S. E. Karlen, formerly director of Aktiebolaget Zinkgruvor, Falun, Sweden, is now acting manager of Riddarhytte Aktiebolag, Riddarhyttan, Sweden.

Michael H. Vallez has been promoted from the technical graduate training program of The Anaconda Co., Butte, Mont., to assistant shift foreman of the Chile Exploration Co., a subsidiary of Anaconda.

Robert S. Burton, formerly mine superintendent, Trench Mine, American Smelting & Refining Co., Patagonia, Ariz., has become mine superintendent for the Neptune Gold Mining Co. in Nicaragua.

William Anderson, Jr., formerly mine superintendent of the Banner Mining Co., Tucson, Ariz., has now become superintendent of the Star Mine for the Hecla Mining Co., Wallace, Idaho.

John D. Rankin has become superintendent for Forsberg Mining Ltd. at Lynn Lake, Man., Canada. Formerly he was managing director of Miners Incorporated S. A., Lima, Peru.

Erwin Gammeter, formerly project manager for Hamilton Overseas Contracting Corp., has now become vice president of Paul Weir Co., Chicago.

J. F. Wickham has become research metallurgist with American Smelting & Refining Co. He was formerly mill superintendent for the same company.

W. B. Hall, formerly mill superintendent at Cyprus Sulphur & Copper Co. Ltd., has become group relief mill superintendent at Messina (Transvaal) Development Co. Ltd., South Africa.

Dalton L. Russell has become plant metallurgist with Cerro de Pasco Corp., Peru. Formerly Mr. Russell was chief metallurgist for Britannia Mining & Smelting Co. Ltd., Vancouver.

R. Massey Williams, mining engineer and geologist, has returned to private practice as a consultant. His headquarters will be in Toronto. For the last five years Mr. Williams had been chief consultant on mining engineering and geology for Continental Mining Exploration Ltd., where, among other things, he was responsible for much of the work that resulted in Faraday Uranium Mines being brought into production.

Personnel changes at the Utah Copper Div. of Kennecott Copper Corp. include: **Thomas Barker, Jr.**, formerly scheduling foreman at the Magna Mill, has been transferred to the same position at the Arthur Mill. **Clinton P. Mott**, former division industrial engineer, has been transferred from the staff to operations and will assume the duties of scheduling foreman at the Magna Mill. **William B. York,** formerly division industrial engineer at the Nevada Mines Div., has been appointed division industrial engineer for the Utah Copper Div.

Sylvio de Queiros Mattoso has become assistant professor of a postgraduate course in geology given under a joint agreement between Petrobas (the Brazilian state-owned oil company) and the Universidade da Bahia, Brazil.

W. J. Rude, formerly coal manager with American Gas & Electric Service Corp., has become resident manager with Bislig Industries, A. Soriano y Cia, Manila, P. I. He is engaged in coal mine development on the island of Mindanao.

Stuart V. Bradley has been appointed to the newly created post of staff assistant to director of mineral development and **A. Herbert Axelson** has been named manager-mining engineering for U. S. Steel's Oliver Iron Mining Div. at Duluth. Formerly both men were assistant managers-mining engineering.

Arnold Hoffman has been re-elected director and elected president of the Mesabi Iron Co. Other new officers elected at the company's annual meeting are: **Lanfear B. Norrie,** vice president; **Quincy Adams Shaw, Jr.**, secretary and treasurer; and board of directors members: **Henry T. Mudd, Malcolm S. Mackay,** Mr. Norrie, Mr. Shaw, **Odin A. Sundness, Arthur G. Logan,** and **Isaac Putterman.**

E. N. Pennebaker, formerly a geologist for Consolidated Coppermines Corp., is on a trip into Colorado as a consulting geologist.

B. PYLE

F. R. MILLIKEN

Byron Pyle has been elected president of Kennedy Van Saun Manufacturing & Engineering Corp., of New York and Danville, Pa., to fill the vacancy caused by the sudden death of **Fred O. Reedy.** Mr. Pyle was formerly executive vice president and has been with Kennedy Van Saun for 13 years.

Frank R. Milliken, formerly chief of company mining operations, has been appointed executive vice president of Kennecott Copper Corp. In addition, Mr. Milliken has been elected to the board of directors of Kennecott, along with **Carl K. Lenz,** president of Kennecott Sales Corp., a subsidiary.

T. M. Waterland has left his position as assistant manager at Britannia Mining & Smelting Co. Ltd. in British Columbia, to take a similar position with Upper Canada Mines Ltd., Dobie, Ont. Upper Canada, a gold mining operation, is sinking an additional six levels this year.

Austin Goodyear, executive vice president of Hewitt-Robins Inc., has been elected president of the company, succeeding **Thomas Robins, Jr.,** who has held the dual positions of chairman of the board and president. Mr. Robins will continue as chairman of the board and chief executive officer.

Melvin Williams, health and safety engineer with the U. S. Bureau of Mines, Pheonix, Ariz., is now with the Bureau's district office in Seattle.

Ray J. Leone, formerly with St. Joseph Lead Co. at Bonne Terre, Mo., is now with the Geology Dept. of White Pine Copper Co., Mich.

personals

continued

Officers of the Lead Industries Assn. for 1958-1959 are: president and chairman of the board of directors of the association, **John D. Bradley**, The Bunker Hill Co.; vice presidents, **F. S. Mulock**, U. S. Smelting Refining & Mining Co.; **Felix Wormser**, St. Joseph Lead Co.; and **Kenneth W. Green**, The Electric Storage Battery Co.; and secretary-treasurer, **Robert L. Ziegfeld**. John D. Bradley, F. S. Mulock, and Kenneth W. Green have also been elected to the board of directors. Other board members elected are: **R. D. Bradford**, American Smelting & Refining Co.; **K. C. Brownell**, American Smelting & Refining Co.; **W. H. H. Cranmer**, New Park Mining Co.; **J. A. Costello**, The Ethyl Corp.; **H. L. Day**, Day Mines Inc.; **Andrew Fletcher**, St. Joseph Lead Co.; **Clarence Glass**, International Smelting & Refining Co.; **J. A. Martino**, National Lead Co.; **Rueben Viener**, Hyman Viener & Sons; **Jean Vuillequez**, American Metal Climax Inc.; **William Wilke, III**, Hammond Lead Products Inc.; and **Miles M. Zoller**, The Eagle-Picher Co.

W. Lunsford Long, chairman of the board of Haile Mines Inc., has announced his retirement and his resignation of all official positions with the company and its subsidiaries, as well as the presidency of The Tungsten Inst., which he organized. Mr. Long will be available as consultant for Haile, but will devote himself largely to his family and private affairs. Haile Mines Inc. is merging with Howe Sound Co., and Haile president **William M. Weaver, Jr.**, has become president of Howe Sound Co.

Eastman J. Hatch has been elected to the board of directors of Federal Uranium Corp.

Lawrence F. Black has been appointed to the newly created position of manager of Utah Operations, U. S. Steel Corp. Columbia-Geneva Div. **A. E. Terry** has become general superintendent, and **Carl J. Fordum** assistant general superintendent, of Geneva Works. Mr. Black will also serve as manager of operations for U. S. Steel's subsidiary Columbia Iron Mining Co.

Kerry L. Van Gilder has left his position as junior mine engineer at Manganese Inc., and is attending Mackay School of Mines, University of Nevada, working for a master of science degree in geology.

William J. Fox has been elected vice president for the field of technological growth and **Elliot J. Roberts** has been appointed company technical advisor by Dorr-Oliver Inc., Stamford, Conn. These are two newly created top level posts which are the first steps in a research and development reorganization and realignment.

W. J. FOX

E. J. ROBERTS

Wallace F. Ferris, president of the Meriden Iron Co., Minneapolis, has been elected to the board of directors of the E. J. Longyear Co., also of Minneapolis.

C. B. Bradford has become chief electrical engineer for the Southern Peru Copper Corp. in Toquepala, Peru. Formerly he was an electrical engineer with the company's Denver plant.

D. W. M. Ross has been elected president of Joy Manufacturing Co. Ltd. He succeeds **James A. Drain**, who has been elected chairman of the board. Mr. Drain is also vice president and general manager of the Mining and Construction Div. of the parent company, Joy Manufacturing Co., Pittsburgh.

Kenneth A. Johnson has become a coal technologist with the U. S. Bureau of Mines at Anchorage, Alaska. He was formerly a chemist at the Northwest Experiment Station, USBM, Seattle. With almost 20 years of membership in the AIME North Pacific Section, Mr. Johnson was vice chairman of the Section at the time of his relocation to Alaska. His activities in Alaska include inspection of coal sampling at military bases and analysis of coal purchased by the military as well as sampling at coal mines along the Alaska railroad.

Leslie J. Conley, formerly mine superintendent for Shannon Mining Co., a subsidiary of Peru Mining Co., has been transferred to the parent company offices in New Mexico following the shutdown of the Shannon property.

D. W. JOHNSON

P. D. V. MANNING

Donald W. Johnson has become plant manager of Reynolds Metals' Longview, Wash., aluminum reduction operations. Formerly he was assistant plant manager at the company's Troutdale, Ore., reduction plant. Mr. Johnson succeeds **V. G. Kneeskern**, who has been named manager of Reynolds Metals' new St. Lawrence aluminum reduction plant at Massena, N. Y. Both men are active AIME members; Mr. Johnson is secretary-treasurer of the Oregon Section.

Paul D. V. Manning, who will retire from his position as senior technical vice president, International Minerals & Chemical Corp., Chicago, on June 30, has been appointed professor of chemical engineering at California Institute of Technology. Dr. Manning will take up his new position immediately upon retiring from International Minerals.

Frank M. Makarinsky of the Falconbridge Nickel Mines Ltd. has been transferred to the Fecunia mill in Onoping, Ont., Canada, as mill engineer.

personals

continued

Herbert L. Rader, formerly process engineer for Universal Atlas Cement Co.'s Northampton, Pa., plant, has moved to the company's Buffington, Ind., plant as assistant general foreman, operating and maintenance.

L. Daniel Langfeldt, mining engineer, has recently assumed duties with the Health and Safety Activity of the U. S. Bureau of Mines, with headquarters in Duluth.

Retired mining engineer **Henry H. Otto** has been selected to receive the 1958 merit award conferred annually by the Northeast Chapter of The Pennsylvania Soc. of Professional Engineers. The plaque is awarded for outstanding contributions to the engineering profession and the public welfare. During his professional career Mr. Otto worked as mining engineer for The Lehigh Valley Coal Co., Wilkes-Barre, Pa.; Lehigh & Navigation Co., Lansford, Pa.; and The Hudson Coal Co., Scranton, Pa. From 1945 until his retirement in 1955, he served as assistant general manager in charge of engineering for The Hudson Coal Co.

Henry K. Martin has been appointed to the newly created position of director of mineral development of Oglebay Norton Co., Cleveland. Formerly superintendent of concentration at Phelps Dodge Corp.'s Copper Queen Branch in Arizona, Mr. Martin had previously been associated with Oglebay Norton as development engineer on the taconite project of Reserve Mining Co.

D. J. Salt, formerly managing director of Geo-Explorers Ltd., has become chief geophysicist of Ventures Ltd., Toronto.

Stuart G. Watt has recently completed graduate work toward an M.S. degree in mineral preparation engineering at Pennsylvania State University and has become operations research analyst for Lukens Steel Co., Coatesville, Pa.

John H. Jett, vice president and general manager of Vulcan-Denver Iron Works Co., was elected vice president and director of General Iron Works, Denver, in January.

Charles A. Mitke is now president of the Manila Mining Corp., Manila, P. I. The company is at present drilling what promises to become a large low-grade copper porphyry.

Ronald Haxby, who recently received a bachelor's degree in geological engineering from the University of Minnesota, has become a geologist for Phelps-Dodge Corp. in Morenci, Ariz.

Glenn D. Robertson, formerly division production manager with Shell Oil Co., who retired after 23 years with the company, has been keeping busy landscaping his new home. Recently he enjoyed a two-month-long vacation in the Rocky Mountains.

F. Stillman Elfred, who recently retired as senior vice president of Olin Mathieson Chemical Corp., has been elected chairman of the board of Peabody Coal Co. In his new position he will continue as a director of Olin Mathieson and as a consultant to that company.

L. F. Pett, general manager of Utah Copper Div., Kennecott Copper Corp., retired on May 1. Mr. Pett has been with Utah Copper since 1922, when he joined the company as a computer in the Engineering Dept. at the Bingham mine. Born in Brigham City, Utah, in 1893, he was graduated from the University of Utah with a degree in civil engineering. During his association with Utah Copper, Mr. Pett moved up through the ranks and was appointed superintendent of mines on Jan. 1, 1950. In December of the same year he was named general superintendent of mines, and became general superintendent of operations in January 1952. He was named to the post of general manager in November 1952. At present Mr. Pett is serving as president of the Utah Manufacturers Assn. He is a past-president of the Western Div. of the American Mining Congress and the Utah Mining Assn.

H. R. Cooke, Jr., formerly a consulting geologist and engineer in Reno, Nev., has now joined the staff of Arnold H. Miller Inc., consulting engineer, New York.

Gordon R. Hilchey, formerly a mining engineer for Canadian Refractories Ltd., is now an engineer-geologist with Conwest Exploration Co. Ltd. in Toronto.

J. H. Ashley, formerly assistant managing director of The Fresnillo Co., Fresnillo, Mexico, has resigned for reasons of health. He has been replaced by **J. B. Stone**, formerly general manager, and **F. W. Bailey** has taken over the position of general manager. Other changes in the operating staff of Fresnillo include the naming of **H. H. Schou** as general superintendent; **Neil Healy**, general mine superintendent; **R. C. Anderson**, mine superintendent, and **H. D. Fine**, assistant mine superintendent.

Robert F. Winkle, formerly mine planning engineer for the Ray mine of Kennecott Copper Corp., has been named pit maintenance foreman. He replaces **R. I. Williams**, who has joined Kennecott's Utah Copper Div. at Salt Lake City.

Walter S. Moore recently retired from his position as field representative and development engineer of the Island Creek Coal Co. and Island Creek Coal Sales Co. He has been retained for consulting service by the Booth Coal Co. Mr. Moore had been with Island Creek Coal for 13 years before retirement.

John L. Landa has been promoted to underground foreman at Pioneer underground mine, Ely, Minn., on the Vermilion iron range, Oliver Iron Mining Div., U. S. Steel Corp.

Walter J. Deptula, Jr. is now raw materials engineer with the Granite City Steel Co. in Illinois.

Thys B. Johnson, formerly a graduate student at the University of Minnesota, has joined the Oliver Iron Mining Div. U. S. Steel Corp., as a mining engineering trainee.

A. Matusiewicz, formerly a mine geologist with the Plomosas Unit, Cia. Minera Nacional S. A., Chihuahua, Mexico, has joined the Santa Eulalia Unit in Chihuahua of the parent company, American Smelting & Refining Co., as an assistant mine foreman.

M. A. Nelson has become secretary-treasurer of a newly incorporated company, Odgers Drilling Inc. Formerly a father-son partnership, Odgers now intends to expand its drilling activity and facility to include drilling nationally and internationally. The company's new services will include diamond core drilling, soil sampling, foundation investigation, and related activities. Mr. Nelson was formerly assistant sales manager of E. J. Longyear Co.

J. David Lowell, formerly with International Ranwick Ltd., an associate company of Ventures Ltd. of Toronto, is now resident manager of the Tucson exploration office of Southwest Ventures Inc.

J. R. Othick has become mill superintendent of Cia. Minerales Santander Inc. The mill is being built and stripping of the overburden is under way. Formerly Mr. Othick was mine superintendent for Northern Peru Mining Corp., an Asarco subsidiary.

Willis Perry Mould, formerly president of Mining & Quarrying Assoc., has become manager of the Vermont Kaolin Corp. The latter company is developing a residual kaolin deposit of high quality on its mineral properties in Monkton, Vt.

Peter H. Cooper has become Middle East representative for the Joy Manufacturing Co. He will be based in Beirut, Lebanon.

C. Maxwell Norman, a director and consulting and mining engineer for Camp Bird Ltd., has announced a change in locale of the head office

personals

continued

of the American branch from New York to Suite 2110, First National Bank Bldg., Denver 2, Colo.

George G. Ference and **Peter F. Mataich** have joined the Engineering Div. of International Minerals & Chemical Corp., Chicago. Mr. Ference, formerly assistant technical director with Liberty Powder Defense Corp., Baraboo, Wis., will become a chemical engineer at International. Mr. Mataich, formerly a project supervisor in the Metallurgy Dept. of Horizons Inc., Cleveland, will be a statistical engineer.

Robert J. Wright, formerly supervisor of exploration for Climax Uranium Co., has become manager of the Denver exploration office of American Metal Climax Inc., the parent company.

Keith C. Stansmore has been appointed manager of the International Sales Area, Dorr-Oliver Inc., following the retirement of **Peter M. Contant**, manager, Northern Div. **Neil Munro** has been appointed division manager international sales, assuming the duties previously handled by Mr. Stansmore. Mr. Contant will continue with International Sales on a special consulting basis.

Obituaries

Rupert Garrison (Member 1951) of Virginia City, Mont., died on May 12, 1957. He had been president and general manager of the Garrison Mining Co. Mr. Garrison was born in Chicago in 1897 and was educated in Ontario, Washington, and the School of Mines at the University of Washington. He had been assayer for the Keystone Mining Co. in Utah, manager of the Ruby Valley Mine in Montana, and president of the Virginia City Mining Co. Before managing the Garrison Co. he was mine inspector and safety supervisor in chrome mines in Columbus, Mont.

Benjamin W. Knowles (Member 1916) died on Nov. 14, 1957. Born in Denver in 1886, he received an E.M. degree at the Colorado School of Mines in 1908. He started his career as an assayer and became an engineer for the Hedley Gold Mine Co., Hedley, B. C., Canada, where he was mine superintendent until 1932. For two years he was engaged in consulting engineering before he became general superintendent of the Kelowna Exploration Co. He was later a mine engineer in Colorado Springs, Colo.

Leroy A. Palmer (Member 1953), U. S. correspondent for *The Mining Journal* (London), who resided in Portland, Ore., died recently. Born in Lockport, Ill., in 1895, he attended high school in Grand Rapids, Mich., and gained higher education in civil and mining engineering through correspondence courses. His general engineering experience began in railroad construction and mining, mill work, and copper and lead concentration, until in 1909 he was chief of a field party for the Salt Lake City engineering department. He began writing articles on mining and metallurgy for magazines in the U. S. and England, starting a career in engineering journalism that continued along with his field experience until his death. From 1911 to 1931 he was field engineer for the U. S. General Land Office, engaged in geological and engineering examinations, giving testimony in courts and at departmental hearings.

He then entered private practice in San Francisco for 11 years. In 1942 he was field engineer for the California Bureau of War Minerals. In 1943 he was construction engineer, dredging supervisor, and safety inspector for the Moore Dry Dock Co. He was also safety inspector for the Naval Supply Depot and later safety supervisor for the U. S. Marine Corps Depot of Supplies. He had been vice chairman of the California State Mining Board and chairman of the Section on Mineral Industries, Commonwealth Club of California, during his varied career.

Edward C. Schwartz (Member 1947) died on Feb. 1, 1957. He was born in Hazleton, Pa., in 1885 and attended school in Hazleton. He worked for the Lehigh Wilkes-Barre Coal Co. and became general superintendent of the A. E. Dick Contracting Co. in Hazleton.

Edward H. Stevens (Member 1950) died in Birmingham on Mar. 3, 1958. He was chairman of the AIME Southeast Section at the time of his death. Born in Birmingham in 1917, he was educated at the Colorado School of Mines and received a B.S. in mining engineering at the University of Alabama in 1947. He began as an ore miner and alternated his studies with five years as an engineer officer in the U. S. Navy. For two years he was manager and partner in the O. D. Lindstrom Equipment Co. and in 1949 became project engineer and later superintendent of industrial relations for the Tennessee Coal Iron and Railroad Co.

Omar C. Wilson (Member 1957) was drowned on July 26, 1957, at Bethany Beach, Del., where he was vacationing with his wife and family. He was assistant manager of market research for the Consolidated Mining and Smelting Co. of Canada Ltd. Born in Ottawa in 1910, he received a B.Sc. degree in metallurgical engineering at Queen's University in 1933. His career began as a mill operator for Hollinger Consolidated Gold Mines Ltd. In 1934 he joined the staff of the International Nickel Co. of Canada Ltd. Here, in the copper refining division he advanced from wire bar castings foreman through various stages of training and responsibility until he was appointed general foreman and assistant to the superintendent of the castings department. In 1942 he took a Government position in the Office of the Metals Controller where he was promoted and then transferred to the Dept. of Administration, War Time Prices and Trade Board in connection with nonferrous metals. He returned to private industry in 1947 to the Metal Sales Div. of Cominco where he advanced to the position he held at the time of his death.

Necrology

Date Elected	Name	Date of Death
1918	M. H. Caron	Feb. 20, 1958
1933	Edward L. Carow	Dec. 22, 1957
1909	Frank W. De Wolf	Sept. 16, 1957
1934	Gordon E. Dunlap	Apr. 8, 1958
1934	George G. Gallagher	Mar. 24, 1958
1921	H. L. Griffin	Mar. 29, 1958
1951	Polykarp Herasymenko	Apr. 6, 1958
1952	Victor H. Jones	Mar. 6, 1958
1937	S. R. Kallenbaugh	Apr. 21, 1958
1940	Carrel B. Larson	Mar. 6, 1958
1903	Horace F. Lunt Legion of Honor	Aug. 10, 1957
1949	Norman E. Maclean	Nov. 2, 1957
1950	John N. Marshall	Apr. 16, 1958
1946	John W. Monson	Apr. 1, 1958
1942	C. Wesley Potter	Apr. 9, 1958
1957	H. L. Sargent	November 1957
1947	George V. Slottman	Apr. 21, 1958
1950	Walter A. Smith	Feb. 14, 1958
1916	Eugene E. Whiteley	Mar. 19, 1958

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Society of Mining Engineers of AIME

Total AIME membership on May 31, 1958, was 29,842; in addition 3,020 Student Members were enrolled.

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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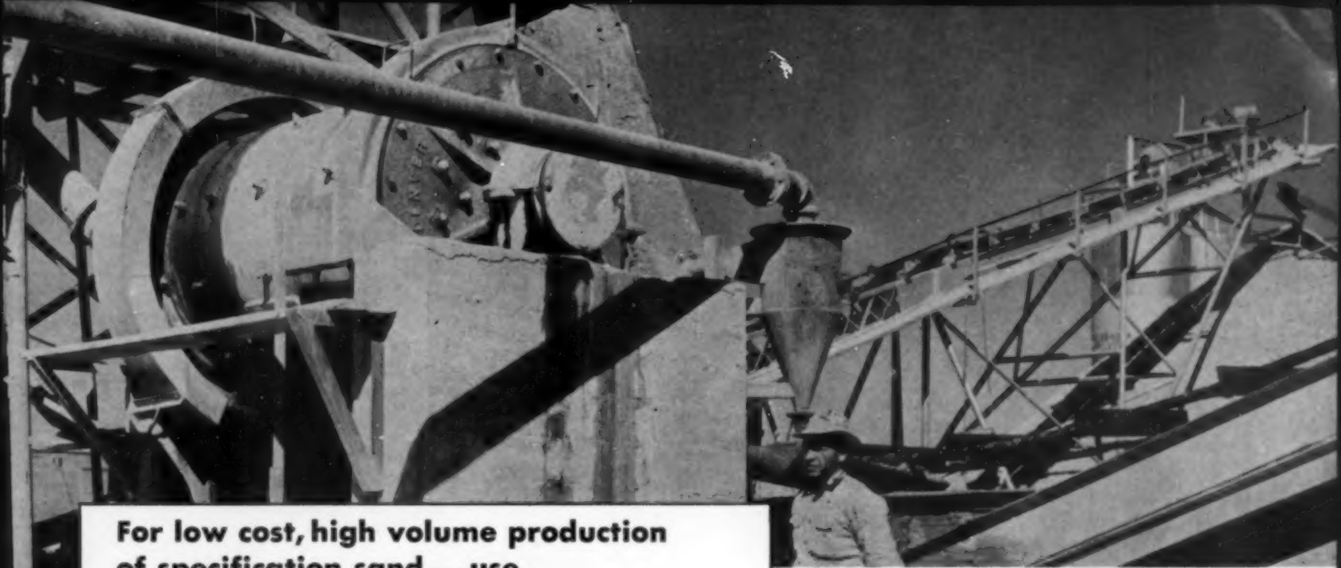

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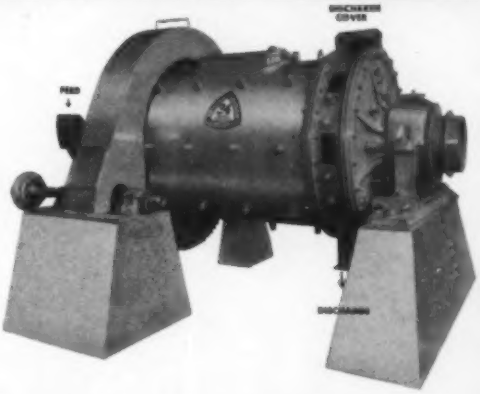

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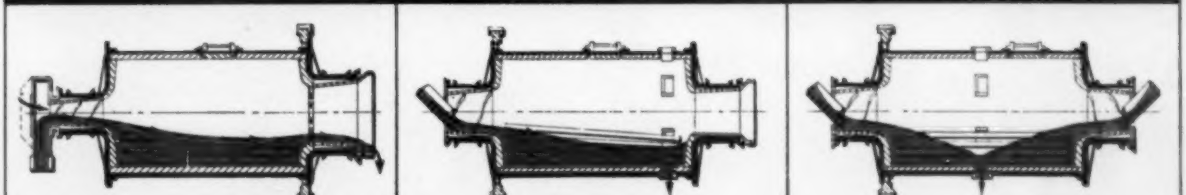

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